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THE POPULATION POSSIBILITIES OF CANADA

DIAMOND JENNESS

WORKING with data compiled just before the war by the International Institute of Agriculture in Rome, Professor East computed that it required about 2.2 acres of cultivated land to feed each person in western Europe, where the production per acre was greater than in the United States or Canada and the standard of living less high. Surveying the world as a whole, he estimated that it would require at least 2.5 acres of arable land per capita to permit of a standard of living approaching that of today in the United States. Then, calculating the maximum potential area of arable land in Canada at 150,000,000 acres, and assuming that whatever food were exported would be balanced by an equal quantity imported, he obtained as the maximum population that Canada may eventually support a total of 60,000,000 people.[1]

There has never been an accurate survey of Canada to

	Estimated Possible Farm Land	Occupied as Farm Land 1921
Prince Edward Island	1,258,190 acres	1,216,483 acres
Nova Scotia	8,092,000 "	4,723,550 "
New Brunswick	10,718,000 "	4,269,560 "
Quebec	43,745,000 "	17,257,012 "
Ontario	56,450,000 "	22,628,901 "
Manitoba	24,700,000 "	14,615,844 "
Saskatchewan	93,458,000 "	44,022,907 "
Alberta	97,123,000 "	29,293,053 "
British Columbia	22,618,000 "	2,860,593 "
Total	358,162,190 acres	149,887,903 acres

[1]East, E. M. Mankind at the Crossroads, New York, 1923, pp. 70f, 86: The per capita acreage required by the different European countries were. Germany, 2.0; France, 2.3; Italy, 2.4; Belgium, 1.7.

determine the exact amount of its arable land and the varying grades of soil, but the Canada Year Book for 1924 and following years offers the foregoing table of what it terms farm land.

Now 350,000,000 acres is a very imposing figure. It is more than double East's estimate of our arable land; it exceeds the total acreage sown in wheat by all the countries of the world combined. But is the estimate reliable? The amounts attributed to Saskatchewan and Alberta seem suspiciously high, for these and other provinces contain enormous areas of imperfectly mapped lands whose reserves are hardly known.

Quite recently, the National Development Bureau of the Department of the Interior, Ottawa, made an independent estimate. It divided the incompletely surveyed parts of each province into lots, and hazarded for each lot a rough determination of the proportion of farm land by checking the descriptions of survey parties and miscellaneous travellers against maps and figures showing the altitudes, rainfall and length of the growing season. The figures it obtained in this way diverge widely from those of the Year Book:

Estimate of Possible Farm Land, Compiled by the National Development Bureau about 1928

Prince Edward Island	1,200,000 acres
Nova Scotia	5,000,000 "
New Brunswick	10,000,000 "
Quebec	40,000,000 "
Ontario	55,000,000 "
Manitoba	25,000,000 "
Saskatchewan	60,000,000 "
Alberta	72,000,000 "
British Columbia	22,000,000 "
Total	290,200,000 acres

Thus at the very outset of our enquiry we find ourselves squarely on the horns of a dilemma; for no investigation of the population possibilities of the Dominion can have the slightest value unless it is directly based on the area of cultivable land. Of the three estimates that have been presented to us, which are we to take? If we reject all of them our enquiry immediately falls to the ground, for we could not make a new estimate at the present time without traversing exactly the same ground as the officials of the National Development Bureau whose estimates we had deliberately thrown overboard. East's figure is not really comparable with the other two, because it relates only to the land that can be laid under the plough, whereas what is called farm land always includes a considerable proportion that is not arable.[2] On what basis the Year Book founded its estimate other than the 1921 census of the occupied lands we do not know; for this very reason, and also because it is the earliest in date and the most optimistic, prudence bids us pass it by. Like the agent for a trans-Atlantic liner, we can only determine our accommodation by the space that seems relatively assured. Not unless future information definitely increases the space at our disposal, dare we embark more passengers for our promised land.

We will accept, then, the estimate of the National Development Bureau, and reckon that the farm land at our disposal amounts to some 290,000,000 acres. More than half of the area, some 150,000,000 acres, was already occupied at the time of the 1920 census, but of this occupied portion only 62,000,000 acres were actually cropped ten years later. Wheat accounted for about 40%

[2]Baker gives our potential area for growing wheat as 400,000 square miles, or 256,000,000 acres (Baker, O. E. The Potential Supply of Wheat, Economic Geography, Vol. 1, No. 1, March, 1925, p. 40); but he has probably derived this figure from the Year Book's estimate of the available farm land.

of the crop acreage, other cereals 32%, and hay, clover and alfalfa, 17.5%. Doubtless part of the occupied land was allowed to lie fallow, part was quite unsuited for agriculture, and part consisted of woodland supplying timber and fuel that were locally of more value than extra crops. If conditions become more favourable, however, the acreage in crops on these occupied lands can probably be raised from 41% to 55%, from 62,000,000 acres to 82,000,000.

The 140,000,000 acres of agricultural land computed as still unoccupied includes 52,500,000 acres now covered with forest,[3] nearly a million acres of semi-arid land in southern Alberta and southern Saskatchewan that calls for irrigation, and an uncertain amount of marsh land that requires drainage. The marsh land forms probably but a small percentage, since the officials of the National Development Bureau tried to eliminate it from their calculations. On the occupied lands of British Columbia, which has a higher proportion than any other province, it averages 7.63%;[4] so if we make it 8% of our unoccupied farm lands, or roughly 11,000,000 acres, we ought to be quite safe. The remainder, amounting to about 75,500,000 acres, seems to be all grass-land or "park"-land. What proportion of the unoccupied land possesses soil of even moderate fertility is, of course, undetermined. It certainly includes large tracts—*e.g.*, between Lakes Winnipeg, Winnipegosis and Manitoba—where the ground is too stony or sandy, or too deficient in moisture, for the yield to repay the cost of cultivation under any but the most exceptional market conditions; also districts where the chances of low summer temperatures and early frosts make agriculture on any extensive scale an extremely

[3]The Forests of Canada, revised for the Third British Forestry Congress, Ottawa, 1928, p. 11.
[4]Census Reports for 1921, Bull. 11, Table 15.

hazardous enterprise, even though the grain-growing area may expand beyond its present limits through the discovery of earlier-ripening and rust-resistant strains,[5] and hardier grasses and hardier stock may permit an extension of dairying and mixed farming. Large areas in the Peace River basin, on the other hand, and the irrigable land of southern Alberta and southern Saskatchewan, are highly fertile. We may reasonably conjecture that about two thirds of the grass and "park"-land, one half of the forested, and one third of the swamp land, possesses soil of moderate richness and is blessed with a favourable climate.[6] Hence if we subtract from the area of unoccupied farm land one third of the grass and "park"-lands, one half the area of the forested and two thirds the area of the swamp lands, we have left about 80,000,000 acres which man may one day find profitable to cultivate. Add to this 80,000,000 the other 80,000,000 acres of agricultural land already occupied, and we obtain a total for the whole of Canada of 160,000,000 acres.

There is still one further correction we must make in our figure. Roads, railways, town-sites and farm-buildings, withdraw from cultivation an appreciable quantity of good farm land. The proportion naturally varies in different countries, and in different sections of the same country; but usually it seems to run between 5% and 8%.

[5]Mr. L. H. Newman, Dominion Cerealist, informs me that the stem-rust in wheat seems at last to have been overcome, that several highly rust-resistant strains have been tested successfully, and that the chief problem now remaining, apparently, is to choose the best of these strains. He predicts that within two or three years rust need no longer trouble the Canadian farmer, and that large areas in southern Manitoba which changed their crop from wheat to barley on account of rust will shortly revert to wheat.

[6]This estimate is perhaps ultra-conservative. Officials of the Federal Department of Agriculture believe that the arable portion of the grass-and park-land may be as high as 85%. Similarly, of the 82,260 square miles of forested land that is considered agricultural, the officials of the Forestry Branch hold that 30,000 will probably be retained as woodland, but that nearly all the reat can be placed under cultivation. Thus the amount of arable land not now occupied may be as high as 102,000,000 acres. I have preferred the lower and less optimistic estimate, however, to avoid any suspicion of exaggeration.

For Canada it will be safer to assume the higher proportion, 8%, because of the further diversion of land through the planting of more and more trees on the formerly treeless prairies, which comprise about half the agricultural area of the Dominion. With this correction, our final estimate of the agricultural area falls a trifle under 150,000,000 acres. Doubtless the progress of further surveys will necessitate some revision of this figure, but it seems impossible today to improve upon it.

Thus by a circuitous and perhaps tedious route we have arrived at approximately the same estimate as East. Although Canada may claim sovereignty over more than 3,500,000 square miles, less than a fifteenth of its area, only about 150,000,000 acres, can be profitably turned with the plough. Instead of marching in the front rank of agricultural countries with the United States, Russia and Argentina, it shrinks back into second place with Germany. Its agricultural resources are great, but they are not as great as many people imagine.

Now on the hypothesis that the maintenance of our present standard of living in North America necessitates 2½ acres of arable land for every individual, East deduced for the Dominion a maximum population of 60,000,000. Other writers have ventured the opinion that the country can support up to 100,000,000 and even beyond, but they give no grounds for their estimates, which in most cases seem to be no more than vague guesses.[7]

Let us approach the problem from an angle slightly different from East's. Let us survey briefly the principal resources of the Dominion and see what possibilities they hold out for a large and prosperous population; and let us

[7]Thus Leacock, on the basis of a fantastic comparison with north-western Europe, says that Canada could support 250,000,000 people (Leacock, Stephen. Economic Prosperity in the British Empire, p. 50, Toronto, 1930).

examine first its possibilities for the production of food.

At the present time about 40% of our cultivated land is sown in wheat. This is a very high proportion; for the United States (whose climate, however, permits a greater variety of production) devotes only about 15% of its cultivated area to wheat, and France, which strives in every way to be self-supporting, only 28%. Why the proportion in Canada should be so high does not concern us at this moment. The important thing is that instead of increasing it must almost certainly decrease, for dependence on a large scale wheat production not balanced by other crops produces a condition of perpetual instability that hinders the country's progress on an even keel. It breeds chronic unemployment, because other industries cannot absorb the thousands of labourers who are thrown on the employment market directly the harvest ends;[8] it demands an enormous transportation system that functions fully for two or three months only, and piles up heavy charges during the remainder of the year; and it strains the whole credit system of the country whenever low yields or low world prices such as we have witnessed in recent years cut down or destroy the farmers' profits. Mixed farming avoids the loss of fertility, reduces the danger of shifting soil, and through its variety of resources dilutes the damage from weeds, insect pests and plant diseases. It furnishes employment at every season, and distributes its costs and returns throughout the year, so that it neither ties up credit nor accumulates a heavy burden of interest charges. It is true that in a new and still sparsely settled country it does not yield as quick returns as wheat, and that the marketing of its products abroad has always presented greater difficulties,

[8]The increased use of big harvest combines has alleviated this situation to some extent.

partly because of their character, and partly through the checks imposed by such factors as tariffs and embargoes. An increase of population, however, will change these conditions, and a larger domestic market combined with rising land values and higher costs per acre will surely force more and more of our farmers to avoid the hazards of a single crop and to conserve the fertility of their soil by varying their production, by raising more livestock, rotating their cereals with leguminous plants and using both natural and artificial fertilizers. So the proportion of cultivated land devoted to wheat will probably diminish to about 30%. Even this would seem a high proportion were it not that large areas of the Dominion enjoy more favourable conditions, both of soil and climate, for growing the hard varieties of wheat than any other country in the world (except possibly the U.S.S.R.), and that in the drier parts of the prairie provinces, particularly in southern Saskatchewan, where the winter snowfall is usually light and the variable rainfall averages only from 11″ to 13″ a year, any ordinary rotation of crops is impossible and wheat alone of all the food plants yet evolved seems able to withstand the long-continued droughts. Furthermore, of the various cereals that predominate in the world's food supply the nations of western Europe and of North America have habituated themselves to wheat, and it would require unusual pressure to force them to modify their diet by a greater use of buckwheat, oats, barley or rye.

We need have little hesitation, therefore, in setting aside 30% of the total agricultural area, some 45,000,000 acres, for the production of wheat. The average yield per acre between 1920 and 1929 was 17 bushels; in favourable years it has reached as high as 23 bushels, in unfavourable (as in 1924) as low as 12. Of countries whose

climates, insofar as they concern the growing of wheat, compare favourably with our Canadian climate the United States has a slightly lower average, 15 bushels, France a little higher, 20 bushels, and England higher still, 30 bushels. English and French farms are smaller than American, and give this higher yield through a careful rotation of crops, the expenditure of much more labour per acre, the greater use of fertilizers,[9] and the ability, lacking in most parts of Canada, to grow autumn (*i.e.*, fall or winter) wheat. In Ontario, and on the prairies, our farms have tended to become larger instead of smaller, but they may possibly decrease again, at least in the zones that favour mixed farming, as an increased population raises the value of the land and supplies bigger domestic markets for both animal and vegetable products. In the broad dry belt of the central prairies, where no crop thrives except wheat and mechanized agriculture on a large scale gives high returns at a very low cost, large farms, larger even perhaps than those of today, may hold their own; for there a division into small farms would increase the cost of production without correspondingly increasing the yield, and create a class of "Chinese" farmers toiling sixteen hours a day with inadequate machinery for a bare livelihood. In both areas, however, on the large mechanized farms devoted solely to wheat and on the smaller farms that rotate their crops and carry a number of live stock, we may look forward to higher yields than today because fertilizers have become cheaper and more abundant, and the more

[9] "The average yield of wheat in England about the period 1830-1840 was about 20 bushels per acre, and this represented the level of fertility which could be obtained under the old conservative and very carefully designed rotation then followed. There followed the introduction of artificial fertilizers . . . and within 30 years, by 1870, the level of fertility of English soil had been raised to yield an average crop of 30 bushels of wheat" (Sir Daniel Hall, The Fertilizer Position and European Agriculture, La Technique Agricole Internationale, Vol. 1, Nos. 1-2, Janvier-Juin, 1931).

drought-resistant and rust-resistant strains that are now being evolved will lessen the danger of crop failures. Even in the most unfavourable years, therefore, we should harvest at least our present average, 17 bushels per acre, and our normal yield should be 20 bushels if not more. Thus our 45,000,000 acres of wheat land should furnish us with about 900,000,000 bushels. It is on the normal yields that we must estimate, not on the most favourable, in order to leave a safe margin against privation and want. Even though in many years the crop might greatly exceed this total, it would not warrant any increase of the population it sustained; for human beings should take more forethought than rabbits, and not expand their numbers and outlays in seasons of plenty only to contract them again when the seasons are lean.

The people of Canada consumed annually 4.7 bushels of wheat per capita, on the average, during the years 1920-1929. The inhabitants of the United States and of Great Britain averaged 5.8 bushels between 1909 and 1913, those of France 8.4 bushels, and of Italy 6.4. Germany averaged only 3.3 bushels, but this was because of her greater consumption of rye.[10] These figures do not take into account the amount reserved for seed (in Canada about 1½ bushels to the acre) or fed to poultry and stock. Our 45,000,000 acres would require about 70,000,000 bushels for seed, and our poultry and stock, with the wastage in cleaning, 60,000,000. Thus there would remain about 750,000,000 bushels for human use. At our present rate of consumption this would supply bread for 160,000,000 people; at a rate approximating that of the United States and Great Britain, for 130,000,000, and at France's rate of consumption, about 90,000,000.

[10]Figures, except for Canada, from Baker, O. E., *op. cit.*, p. 21.

Man, of course, cannot live by bread alone. He requires a number of other foods to supply the proteins, fats and vitamines that are lacking in wheat and wheat flour. Furthermore, he has many needs over and above those of his stomach. He cannot even survive in Canada without clothing and shelter, and abundant supplies of fuel to warm his home. Hence we cannot say that the possible population of Canada depends on its possible production of wheat unless we are certain, first, that we can produce practically all the other foods that are necessary to maintain our present dietary standard, and, second, that we shall not be compelled to export a large proportion of our wheat to pay for the fuel, raw materials and manufactured goods that we cannot supply from our own resources.

Now the 1923 Year Book of the United States Department of Agriculture has listed the proportionate consumption of the various foods that enter into the diet of our southern neighbours, and this list will hold good, in the main, for Canada also.

Vegetable Products 60.4%		Animal Products 39.6%	
Wheat products	25.3	Pork and pork products	15.6
Other cereals	9.2	Dairy products	15.3
Sugars	13.2	Beef and beef products	5.3
Vegetable oils and nuts	5.0	Poultry and eggs	2.0
Potatoes	3.5	Misc. animal products including mutton	1.4
Other vegetables	2.0		
Fruits	2.2		

It is evident from this table that practically two-fifths of our diet consists of animal products. In the tropics man eats very little meat, and even in Europe the consumption is considerably lower than in America. In Germany, for example, animal products constituted only one third of the diet (32.4%) in pre-war times, whereas the consumption of cereals was nearly a fifth more than

in America, and of potatoes 3½ times more. Doubtless Europeans would eat as much meat as we do if they could procure it at a reasonable cost; but their countries are more densely settled than Canada or the United States, and they cannot afford to devote as much land to the raising of animals as we do, because that would cut down their farming, and on good arable soil sufficient to support one cow they can grow crops of several times a cow's food value. Canada, however, is in a more advantageous position than western Europe. It possesses large tracts of land, principally in the southern prairies, in the Peace River and adjacent areas, among the eastern foot-hills of the Rockies and in the interior of British Columbia, that are not suited for farming, but will support numerous herds of range cattle and multitudes of sheep. The purely grazing lands of the Dominion, indeed, as distinct from farm lands, probably amount to between 15,000,000 and 20,000,000 acres.[11] Some writers would add to this area the vast stretches of tundra in the far north, because in the not too distant future they may support large herds of domesticated reindeer. It seems very improbable, however, that the reindeer industry will ever augment effectively the meat supply of the more settled parts of the Dominion, or indeed of any part except the north country itself.[12]

[11]Estimate by National Development Bureau. Over 7,000,000 acres are occupied under lease in the four provinces Manitoba, Saskatchewan, Alberta and British Columbia, and a certain amount is held by title. So about half our grazing lands have been taken up already.

[12]The total land area of our Northwest Territories is about 1,250,000 square miles; but a fifth of this area is virtually inaccessible except by air, and of the remainder probably not more than half, if as much, contains the vegetation necessary for successful reindeer husbandry. Two of the most favourable regions in Alaska, Seward Peninsula and Norton Sound, have a capacity of from 40 to 60 acres a head; the average for the whole of our "Barren Lands" is not likely to exceed 90 acres a head. If we could destroy all the wolves and most of the wild caribou in the north, if we could train a sufficient number of capable herders and supply them with cheap fuel and other needs, and if we could control the diseases to which reindeer herds are subject, then we might conceivably raise as many as 3,500,000 reindeer. Actually, we shall be extremely fortunate if we succeed

Viewing our vast grazing lands and the facilities for mixed farming in every province, we need have little doubt, apparently, that we can take care of several times our present requirements in meat and dairy produce, especially when we consider that our exports of these products today exceed our imports to the amount of $30,000,000-$40,000,000. Of the remaining items in our menu the principal are sugars, potatoes, and cereals other than wheat.

In 1930 we produced nearly 600,000,000 bushels of oats, barley, buckwheat and rye, about 90,000,000 more than we required for ourselves; and our production of these cereals can be increased in greater proportion than our production of wheat, because buckwheat and rye will thrive on low-grade soils that are not suitable for other crops. The potato fields of the Maritimes, and less specialized farms elsewhere, should provide for all our potato needs. They produced 48,000,000 cwt. of potatoes in 1930, 4,000,000 more than we required for our own consumption.

Sugar we might supply in great measure from our sugarbeets, since in southern Alberta and south-western Ontario we have at least two fairly extensive areas admirably adapted for this crop. Although the industry there is still young, it gave us 70,000,000 pounds of sugar in 1929. Nevertheless, it is probable that we shall always import large quantities of cane sugar from the West Indies and the South Seas in exchange for surplus wheat and fish and for manufactured products.[13] At the present time the consumption of sugar in North America is

in raising one million. Now the meat supply furnished by one million reindeer, each weighing when dressed about 150 pounds, will not modify greatly the diet of 10,000,000 people, even if transportation offers no difficulty and it can be sold on the market as cheaply as beef.

[13]Cf. Robertson, C. J. Geographical Trends in Sugar Production, Geographical Review, January, 1932, pp. 120-130.

abnormally high. Individually, we eat nearly twice as much as Europeans, owing to our excessive demands for luxury products such as candy. Loth as we may be to change our habits, it seems rather doubtful whether this rate can continue indefinitely. The years to come may witness a lower consumption of sugar, and a greater consumption of foods like potatoes that can be placed on the table more cheaply.

Other articles that we cannot ourselves supply, but of which we consume considerable quantities, are the farinaceous foods rice, sago and tapioca, the beverages tea, coffee and cocoa, sub-tropical or tropical fruits such as oranges and bananas, and fruits and vegetables that mature in more temperate lands during our winter and early spring. These, like cane sugar, we must presumably purchase with surplus food products, with minerals and with manufactured goods.

Canada's food resources, then, seem to be well assured. She will be able to balance her wheat production with a production of nearly all other staples proportionate to their necessity. She need never dread a food shortage, for the tropical, subtropical and locally unseasonable foods she must always obtain from abroad are not absolutely indispensable to her existence or even welfare, however greatly they may contribute to the amenities of life. These foreign foods cost her a trifle over $200,000,000 during the twelve-month period ending March 31, 1930; and during the same period she was able to export food to the value of twice this amount. Since our estimates of the total arable land and of the wheat yield per acre were extremely conservative, it seems probable that even with a population many times that of today, our exports of food might fairly balance our imports, thus preserving us from the plight of the countries in

western Europe, which compete in the world's food markets with their manufactures alone because their own lands supply but a part of their needs and leave them no exportable margin.

Given stable social conditions, then, and efficient transportation, Canada could probably raise enough food to sustain well over 100,000,000 people on very much the same diet as its inhabitants enjoy today. Yet this does not mean that it could support them in other ways, or that the Dominion will ever boast of 100,000,000 inhabitants. No amount of food will banish the cold or turn the wheels of industry; and in resources apart from food the country is rather limited, as we can see by studying the following table of our exports and imports for the year ending March 31, 1930, taken from the Canada Year Book for 1931.[14]

	Exports (Values in millions of dollars)	Imports (Values in millions of dollars)
Agriculture and Vegetable Products:		
A. Mainly food	313	129
B. Mainly non-food	72	98
Animals and animal products (mainly food)	133	70
Fibres and textiles	9	185
Wood, wood products and paper	290	61
Iron and its products	79	317
Non-ferrous metals	154	88
Non-metallic minerals	29	186
Chemicals and allied products	22	40
Miscellaneous commodities	20	74
Totals	1,120 millions	1,248 millions

[14]Page 500f. The figures are given to the nearest million. It should be noted that our exports of grain in this year were $271,000,000 below those of the previous year, owing to the disorganization of the wheat market. The values are based on the declarations of importers and exporters as subsequently checked by the Customs officials.

For the moment the significant items in this table are the fibres and textiles, the iron products and the non-metallic minerals, which are principally coal and petroleum. In the fibres and textiles there are two large items, cotton and silk, which Canada can never produce herself because they are products of tropical or sub-tropical countries. The third large item is wool, which she imports to the value of $47,000,000; for she neither raises today, nor can with certainty raise in the future, enough sheep to supply more than about half the quantity of wool her climate makes necessary.[15] On these three items alone she now spends abroad $13 for every man, woman and child in the country. Even if this rate becomes a trifle lower as our manufactures expand, and we import proportionately more raw materials and fewer ready-made goods, yet apparently it will always remain a heavy and inescapable charge that we can acquit only by exporting in equal ratio products that come from our own resources.

The position in regard to iron and its products is rather peculiar. Speaking in general terms, there are large deposits of iron in many parts of the Dominion, but at the present time it costs us more to extract this iron than to import and reduce the high-grade ores of Newfoundland and Minnesota;[16] and though the easily accessible Minnesota ores that require no beneficiation are being rapidly depleted, those of Newfoundland, even if mined more extensively than today, will last for many centuries. This Newfoundland ore, which is smelted near the coal

[15]Our wool production slightly exceeds 20,000,000 pounds a year. Our consumption, although difficult to estimate, because a large proportion of our woollen imports are manufactured goods, appears to be in the neighbourhood of 40,000,000 pounds.

[16]Some geologists believe that ores similar to those of Minnesota occur in the known extension of the same strata near Thunder Bay in Canada. Even so, they will demand such enormous capital for their outlining and development that the powerful organizations now controlling the Minnesota mines may well secure possession of them and make them subsidiary to their own operations.

mines at Cape Breton, has a phosphorus content that makes it more difficult to reduce than the Minnesota ores, but Cape Breton iron and steel might still compete in Ontario with United States iron and steel if it could avoid the heavy freight charges. Possibly the opening of the St. Lawrence waterways to navigation would alleviate this situation. Even then, however, Cape Breton could not nearly supply all the iron and steel, particularly the special steels, that are needed in Eastern Canada, and it would still be necessary to import huge quantities from abroad. The hydro-electric powers of Quebec might be utilized for smelting Newfoundland or other iron ore if the electric furnace could be operated as cheaply as the blast furnace; but in the production of pig iron the difference of only a few cents per ton decides whether an industry will be profitable or unprofitable, and the higher cost of the electric furnace inevitably debars its use except for special products. Some of our eastern iron deposits contain a certain amount of vanadium, and if we could evolve a process for making the vanadium content pay for the increased cost of extracting the iron we might build up a large industry with our domestic resources alone. There is no evidence as yet, however, that such a process is feasible.

Perhaps, after all, the greatest obstacle to big iron and steel industries in Canada is not so much the character and distribution of our iron and coal deposits as the smallness of our population; for it is not possible to produce iron economically except in quantities so immense that we could neither absorb them ourselves nor sell them abroad in competition with other nations. A huge industrial population west of the Rockies, either in Canada or in the United States, might enable us to work several deposits in British Columbia such as the magnetite

ores on Texada Island; today they lie untouched largely because there is not a sufficient market near the coast to support the production of iron on a large scale, and heavy freight rates block any outlet across the mountains. Again, thirty or forty million people crowded into lower Ontario and Quebec might conceivably develop huge iron and steel industries from domestic ores, serving only the domestic market, whereas with a slightly smaller population it might prove economically impossible.

It would seem, then, that for an indefinite period to come we must resign ourselves to dependence upon outside sources for a large proportion of our iron. We must resign ourselves, also, to the continuous importation of many products manufactured from iron and steel, for apart from nickel, of which we have almost a monopoly, and molybdenum, which is distributed fairly widely both in Canada and in other countries, we have found in Canada only insignificant quantities of the important ferro-alloy metals, manganese, tungsten, vanadium and chromium; and any attempt to build up and maintain with imported ores, and perhaps imported fuels, all the different lines of steel industries that we require would be a very costly and hazardous enterprise. At the present time our bill to foreign countries for iron and its products amounts to over $200,000,000, even after deducting the value of all the automobiles, farm implements and other commodities that we manufacture from iron and ship abroad. There is no certainty that this levy of more than $20 per capita will diminish appreciably with the growth of population, for a larger population will surely bring a greater development of industries, and a greater demand for iron and every variety of its products.

It is more difficult to prophesy concerning coal and petroleum and their products, for which we pay to foreign

countries, principally the United States, the equivalent of about $120,000,000 annually. British Columbia, Saskatchewan and Nova Scotia contain large deposits of coal, and the deposits in Alberta are among the largest in the world; but Ontario has extremely limited supplies, Quebec none; and they are the provinces whose exceptional water-powers close to tide-water, or at least to waters accessible to ocean-going vessels, make for the highest industrial development and the densest population.[17] There is no doubt that Nova Scotia can supply most of Quebec's needs, and that Alberta and Saskatchewan can supply Manitoba. The real crux lies with Ontario, which is so remote from Alberta and Nova Scotia that the inevitably high freight rates greatly restrict the shipment of steam coal from those provinces in competition with the coal that comes in from Pennsylvania and Virginia just across the border. The granting of preferential freight rates across the prairies is only a temporary expedient at the best, and even if the opening of the St. Lawrence waterway to navigation appreciably lowers the charges from Atlantic ports, the coal mines of Nova Scotia cannot enlarge their output sufficiently to supply all the needs of Quebec and Ontario both. Ontario is now lessening its consumption of United States anthracite by using more British anthracite, and more coke, oil and gas; but its industries will demand increasingly large quantities of steam coal whose logical source must always remain Pennsylvania and neighbouring states of the Union. This heavy burden, which we must discharge either with money or with goods, we apparently cannot escape. The most satisfactory solution for Canada would be an interchange of coal whereby Pennsylvania and Virginia would supply

[17]This presupposes the opening of the St. Lawrence waterway to navigation in the not far distant future.

Ontario, and Alberta and British Columbia the States immediately to their south. Alberta and British Columbia do actually send a little coal today into Montana, Idaho and Washington, and British Columbia receives some from Washington in return; but the United States is in a stronger position than Canada to keep down its imports, and the urgent necessities of Ontario can hardly fail to leave a debit balance on our side of the ledger.

Even less satisfactory is the oil situation. The Ontario wells between Lakes Huron and Erie are giving lower yields, and geologists believe that this oil-field, once of the first magnitude, is becoming exhausted. Numerous wells have been sunk in the prairie provinces, principally in the Turner Valley southwest of Calgary; but though they have tapped a huge accumulation of natural gas, their production of oil has been far below expectations. Yet the sinking of these wells in the Turner Valley has greatly increased our knowledge of the geological formations in the region, and of the manner in which the oil is accumulated; and this knowledge still gives ground for hoping that new wells sunk in other parts of the same area may reveal oil reserves of great magnitude. Farther north, it may be possible one day to recover oil commercially from the bituminous sands on the Athabasca River near McMurray; and along the Mackenzie River between Norman and the Ramparts, not far from the Arctic Circle, geological conditions favour a considerable oil-field, although the area has been little explored on account of its remoteness from any large market.

In spite of all these prospects, however, there seems little hope of discovering oil reserves numerous or large enough to supply even as much as half the requirements of the Dominion. The invention of some cheap process

for hydrogenating coal might solve most of our difficulties, for then it would probably pay us to run pipe lines from Alberta across the prairies to the head of the Great Lakes. Two or three processes have already been evolved, but any oil we tried to produce by their means would cost us far more than the oil now piped up to us from the United States or brought in by tank steamers. Many scientists feel that oil fuel may not always be quite as indispensable as it is today. They look forward to improvements in the internal combustion engine that will make it economical to burn such fuels as powdered coal; to discoveries in electrical transmission and storage that will permit us to utilize the water-powers in regions as remote as the centre of the Labrador Peninsula and the heart of the Barren Lands; and even to the harnessing of new forces to man's use, perhaps some of the energy that continually bombards our earth from the outer world of space. These, however, are dreams that we may or may not realize. They should not blind us to the stern fact that for years to come we shall require annually many million gallons of oil, and that most of this oil must be purchased abroad.

Thus in three prime necessities of modern civilized life, clothing material, iron and fuel, Canada is undeniably deficient. For these necessities she pays to foreign countries today, when her population is only about 10,000,000, somewhere in the neighbourhood of $46 per capita annually, or a total of $460,000,000;[18] and with every increase of population the figure will mount still higher. Her annual production of gold can never discharge this enormous bill, for although it has grown year by year until it is now larger than that of any other country except South Africa, it is still (in 1931) only a

[18]The average of the figures for 1927, 1928, and 1929, without correction to any common price-level.

little over $50,000,000, only about one-tenth the amount of our bill, and not likely to increase in greater ratio. What else can we export, apart from food-stuffs, to balance the account?

Naturally, we think first of our forest resources, for our newspapers never weary of telling us that our exports of forest products rank second only to our exports of wheat, that we manufacture more paper than any other country in the world, and that, with the exception of the three Scandinavian countries, Norway, Sweden and Finland, we export more wood-pulp. Our exports of wood and paper in 1929 had a value of $290,000,000, and our imports for the same year of only $61,000,000, so that we wrote down a trade balance in our favour of a clear $229,000,000. Can we not draw more timber from our million and more square miles of forest, erect more mills, and increase our exports of wood and paper until they net us a full $500,000,000?

Unfortunately our forests would not maintain themselves under such intensive exploitation, even if we could find markets for double the amount of wood and paper we produce today. Nature works slowly, she does not bring forth a stately tree in a day or a year; and already the new growth that springs up where the old has disappeared no longer suffices to replenish the losses due to fires, insect and fungi pests, and above all the operations of our lumbermen. Reafforestation by human labour is a slow and costly process, whereas Nature will do the work for nothing if we refrain from destroying faster than she can create. So there is a limit to the toll we can take from our forests, and while no one can say that we have actually reached that limit today (for we have not yet made a full inventory of our timber resources, discovered what we ought to know concerning the rates of

depletion and replacement, or learned to defy the ravages of fires and insects), yet we are at least certain that an increase of logging by even one half would rapidly diminish our forests and impoverish the generations that come after us. In fact, so far from expecting a continuous increase in our exports of wood and paper we should rather look forward to a slight decrease, as our towns and cities grow in size and number and demand more of these products for domestic use. We shall indeed be fortunate if we can maintain their export in sufficient volume to give us a favourable trade balance in perpetuity of about $200,000,000.

It may be that there is more hope in our mineral industry. At the present time Canada is perhaps the most mineral-minded nation in the world. Since the days of the Yukon gold-rush almost every year has been notable for some important ore discovery, and now that the aeroplane has brought even the remotest regions within comparatively easy reach exploration is proceeding at a greatly accelerated pace. The mines of the International Nickel Company near Sudbury are the principal source of nickel for the entire world; in our production of gold, as mentioned earlier, we have already surpassed the United States, and rank second only to South Africa; and we export each year large quantities of copper, silver, lead, zinc and cobalt. The threatened shortage in the world's supply of gold, indeed, places a special premium on the production of that metal, and the pre-Cambrian rocks from which we now derive most of our supply cover so vast an area, and are as yet so little explored, that we may reasonably look forward to many new discoveries and a steadily increasing output. We can increase, also, our production of the other five metals listed above, copper, silver, lead, zinc and cobalt, as soon as our domestic

market can absorb them in larger quantities, or we can find foreign markets willing to purchase them at prices that will repay the cost of extraction.

Unfortunately for us, however, other countries have richer deposits and larger reserves of at least four of these minerals than we have. Chile, United States, Belgian Congo, and Rhodesia all surpass us in copper; and United States, Mexico, Australia and Spain in lead. The output of cobalt from the richer ores in the Belgian Congo has already restricted our own production, just as the high-grade asbestos deposits of South Africa have reduced our production of asbestos. Zinc, too, is very widely distributed; the United States produces and consumes more than any other nation, but Belgium, which smelts imported ores, has become its principal broker in the world's markets.[19] It follows, therefore, that world prices over which we have little or no control will govern our production of these minerals, and unless we discover more uses for them, or new and richer sources, many years may elapse before we can export them in very much larger quantities than we do today.[20]

Our resources in silver seem to hold more promise. Mexico and United States produce more than we do and may possibly have larger reserves, even though we seem to have found rich deposits near Great Bear Lake and may find still others elsewhere. But silver is a much rarer mineral than copper, lead, and the other base metals in general use, and it will continue to command a higher price. In recent years the almost universal adoption of a gold instead of a bi-metal standard, the debasing of the silver currency in one or two countries, and the release,

[19]Cf. Leith, C. K. World Minerals and World Politics, p. 63 *et al*, New York, 1931.

[20]Cf. United States Tariff Commission, Report to the United States Senate on Copper, Report No. 29, second series, Washington, 1932.

or threatened release, of large stocks of silver by the Indian and other governments has greatly depreciated its value; but if the nations heed the advice of many economists and bankers, who are already alarmed over the rapidly diminishing supply of gold and its maldistribution, they may rehabilitate silver as a currency. Then its price will advance again, and Canadian mines, by doubling or perhaps trebling their output, will make a far more substantial contribution than today to our export trade.

In the fiscal year ending March 31, 1930, our exports of copper, silver, lead and zinc gave us a favourable trade balance of about $15,000,000. To this our nickel exports, for which the demand does not greatly fluctuate (except in years, like 1931, of great depression), adds $25,000,000; cobalt and asbestos, whose production and export may even decline, $13,000,000; and platinum, cadmium, and a few other minerals about $2,000,000. If we can step up our gold production to $100,000,000,[21] as some writers believe, and our silver production to $40,000,000, then our mineral resources may ultimately secure us each year foreign credits approaching $250,000,000.

There are, however, other aspects to this mineral question. Although we have discovered no aluminium ores in Canada the cheapness of hydro-electric power in the basin of the St. Lawrence has made it profitable to import bauxite from the United States, and, more recently, from South America, and to extract its aluminium, not for domestic use only, but for re-export. Thus in 1930 we imported bauxite ore to the value of $3,000,000, and after providing for some of our own needs, exported aluminium and aluminium products to the value of $16,000,000. We thus capitalized our water-powers for international trade, gave employment to a certain number

[21] It rose to $55,000,000 in 1931, an increase of 27½% over the preceding year.

of our people, and seemingly piled up abroad a credit of $13,000,000. Could we not follow the example of some European countries, and extend this procedure to other minerals in which we are deficient, to textiles, and to merchandize of every kind? In this way we might build up many flourishing industries, reduce our importations of manufactured articles, and more nearly balance our imports of non-food products with our exports.

Probably there will be some progress in this direction, both in the St. Lawrence basin and in British Columbia, but the difficulties confronting its marked expansion seem insuperable. In the first place our water-powers, though immense, are not unlimited, and industries that make use of our own raw materials naturally have the first claim on them. Secondly, it happens that bauxite is peculiarly suited for reduction in the electric furnace, and it is mainly this factor which makes it profitable to transport the crude ore to a source of cheap labour and cheap power. Profitable or not, however, it is extremely doubtful whether the Aluminium Company of America, which controls the aluminium industry in Canada, would ever have erected the great hydro-electric plant on the Saguenay River if the British government had not stipulated, before granting the company permission to mine the bauxite in British Guiana, that it should smelt the ore within the bounds of the British Empire. Certainly Canada would find it very difficult to obtain abroad supplies of other ores, or raw materials, larger than she required for her own consumption, because the mineral resources of those countries that cannot make the fullest use of them within their own borders, for various reasons, are being more and more corralled, often with political aid, by powerful industrial units already established in the great manufacturing centres of western Europe and

the United States;[22] and those powerful industrial units would certainly check in every possible way any independent development in Canada that threatened their own export trade.

It is true that countries have built up, for the most part under the protection of high tariffs on manufactured goods, important industries of which they lacked the raw materials; but unless they have obtained elsewhere financial and in some cases political control of these materials (as Britain controls the Soudan cotton crop) they have rarely been able to export the manufactured goods in competition with more favoured nations. We ourselves have succeeded with rubber, and to a limited extent with hides, but not with other raw goods. Moreover, high tariffs are beginning to prove a boomerang now that industrialization has spread so widely, and the trade and finances of the nations have become so closely interlocked; and if the high tariffs are ever reduced, many of our artificial industries will languish.[23] A world freed from the spectre of constant wars would have much fewer tariffs, because no country would trouble to control ample stocks of all the raw materials—iron, nickel, copper, oil graphite, rubber, etc.—or to foster all the diverse industries that play so vital a part in the prosecution of a modern war. Under such conditions Canada would not need to regret her present difficulties in maintaining large

[22]Thus British interests control the output of tin in the Malay Peninsula, and United States the manganese and vanadium deposits of South America. Recent spectacular indications of this trend have been the rivalry between the Standard Oil Company of America and the Dutch Shell Company controlled by English capital for the world's oil resources; between Japan and other countries for Manchurian iron and coal; and, within Canada itself, between British and American capital for the control of our Sudbury nickel.

[23]Without preferential tariffs automobiles manufactured or assembled in Canada, for example, will not be able to compete with United States automobiles unless our Canadian manufacturers can build up similarly huge organizations controlling as cheap supplies of coal, iron, oils and other materials, or else employing cheaper labour than United States manufacturers, both of which seem highly improbable.

iron and steel industries, for she could at all times purchase whatever iron and steel goods she needed from other countries; and although the more industries she could develop the greater would be her population, a large population is really no more desirable than a small one, provided both have security. Permanent world peace may seem to be still far distant, but high tariffs at least are undergoing reconsideration everywhere, and without high tariffs there are not many raw materials that Canada can import and manufacture on a large scale for the export trade in the face of competition from so many other industrial countries. With her great hydro-electric powers she can import and manufacture for domestic consumption, but almost certainly she must confine her exports largely to the products obtained from her own resources.

Yet we have a few other resources besides our food-products, our forests and our minerals. There is the fur trade, for example, next to the Atlantic fishery our oldest industry. Our exports of furs in 1930 had a value of $19,000,000, and our imports for the same year of $12,000,000. Although the wild fur-bearing animals have greatly diminished in numbers throughout the entire Dominion, fur-farming is still a youthful industry capable of much greater expansion. Furs, nevertheless, can never figure very prominently in our export trade, partly because our home market absorbs so many, partly because the world's demand is limited and largely met by Russia and other countries. So although in furs, hides, fish,[24] stone, whisky and other miscellaneous products we have a variety of exports whose value in the aggregate may

[24]Our fisheries now give us a revenue of about $32,000,000, but since they admit of no marked expansion this revenue will certainly decline as our population grows, and we improve our methods of transporting and marketing fish. At the present time our consumption of fish per capita is altogether negligible.

amount to several score million dollars, other countries will always be sending us commodities of an equally miscellaneous character that will practically square the account.

Far more important than the fur trade is the tourist traffic, that invisible export of our scenic attractions that yet leaves them unimpaired. It is an item that is peculiarly difficult to evaluate, but the Dominion Bureau of Statistics estimates that in 1929 tourists spent in this country approximately $308,000,000, while our own people travelling abroad spent only $122,000,000.[25] If we interpret this in terms of exports and imports, our tourist traffic in that year represented the largest item in our export trade and the commodity whose value exceeded all others except wheat.

What development it will undergo in the years to come no one can predict. If we encourage it, if we maintain our national parks, keep our lakes and rivers well stocked with fish, and preserve our caribou, moose and bear, our mountain sheep and mountain goat, Canada may become as much the playground of North America as Switzerland is of Europe, although, unlike Switzerland, it will be a summer rather than a winter playground. On the other hand, with swifter and perhaps cheaper transportation, the lure of milder winters may draw more of our own countrymen towards California, Florida and the West Indies; or they may travel in greater numbers to the Old World, to view strange lands, strange customs, and those "storied relics of antiquity" which our own Dominion lacks. Although it is impossible to foretell the relative strengths, fifty or a hundred years from today, of these inflowing and outflowing tourist streams,[26] yet the peculiar

[25] Canada Year Book, 1931, p. 614f. In 1930 the figures were nearly 10% lower.

[26] The difference between the liquor laws of Canada and of the United States today undoubtedly helps our tourist trade, but their alteration would probably not influence greatly the ultimate issue.

attraction of our lakes and woodlands, and the much larger population south of the international boundary than to its north, suggest that the inflow will always exceed the outflow as it does today. In that case it may even yield us a trade balance larger than we now enjoy, may raise its value perhaps from a little under $200,000,000 to as high as $300,000,000. Let us accept this latter figure, $300,000,000, since Canadians who have travelled extensively are invariably optimistic about their country, and we have really no definite facts on which to frame a more satisfactory estimate.

* * * *

Now that we have briefly surveyed our natural resources, and our export and import trades, what exactly is our position today? We have in normal years a surplus of agricultural food-products valued at about $500,000,000 and a surplus of meat and dairy produce worth about $80,000,000; but because we import similar foods to the value of about $140,000,000, the net balance in our favour is really $440,000,000 or a little less. Of other products, excluding the tourist trade and the interest on capital borrowed abroad, our exports and imports are around $700,000,000 and $1,000,000,000 respectively, giving us an unfavourable balance of some $300,000,000.[27] Foreign capital invested in Canada exceeds Canadian capital invested abroad by over $4,000,000,000, and the annual interest on this amount comes to about $240,000,000, or $50,000,000 more than we gain from the tourist traffic. On these counts, then, we have an unfavourable trade balance of $350,000,000, which is swelled by various miscellaneous items until it approaches the favourable

[27]These figures are averages for the three years 1927-1929, uncorrected to any price-level.

balance of $440,000,000 derived from our agricultural exports. Clearly it is only by the export of about 40% of our whole agricultural production that we are able to balance all our visible and invisible exports and imports, and keep our ship of state on an even keel. Today wheat contributes three-fourths of the revenue we derive from our agricultural exports, and it will certainly retain a dominant position on account of our exceptional facilities for growing the finest grades in immense quantities.

Peering now into the future, we can foresee many variable factors that will affect the size of our population. A conservative estimate gave us about 150,000,000 acres of arable land, which is nearly 2½ times the amount we cultivate today; and with improved methods of farming we are sure that we can produce at least twice as much food. Our present population of ten millions is able to export surplus food to the value of over $50 per capita, or about $580,000,000 a year; but at the same time we are importing to the value of about $460,000,000 certain necessities—clothing material, iron goods and fuel—that we cannot ourselves produce in sufficient quantities owing to climatic conditions, excessive cost or inadequate resources. These imports will grow with the growth of our population, although at a slightly lower rate if we learn to utilize our fuels more efficiently, and can reduce the proportion of imported manufactured products by bringing in more of the raw materials—raw cotton, silk and wool instead of the woven articles, iron ore or pig iron rather than steel, and crude oil instead of gasoline. Clearly, then, if these were the only necessities we were obliged to import, and if we had no other means of paying for them than by exporting farm products, the maximum population that Canada could maintain, on the same standard of living as today, would be somewhere about

25,000,000.

We have seen, however, that we have many other needs, and a number of other resources over and above our farm products. We import a host of miscellaneous goods ranging from fruits to diamonds, and we attract or permit large amounts of foreign capital to develop and swell our industries. These extra imports we cover by exports of fish, minerals, wood, paper and other products derived almost exclusively from our own resources. Supposing now that we alter this balance by reducing the imports and increasing the exports. Immediately we will gain a considerable revenue which we can use to defray part of the cost of our fuel, iron goods and clothing material, thus releasing more farm products for domestic consumption. Our population can then expand in proportionate ratio without lowering in any way our present standard of living.

Now as far as concerns our exports of forest products, we concluded that, however much they may fluctuate from year to year, they admit of no permanently stable increase. On the other hand, a more intensive exploitation of our non-ferrous metals, and a rise in their prices to somewhere near the level they held in pre-war years, may increase our mineral profits from $50,000,000 to perhaps $250,000,000. The tourist traffic, too, as we conjectured, may swell its revenue from $200,000,000 to $300,000,000, while a gradual decline in the amount of foreign capital invested in Canada, combined with larger investments by Canadians abroad, may possibly reduce our yearly interest payments to other countries from $240,000,000 to $40,000,000. Perhaps, too, the cheapness of hydro-electric power in the St. Lawrence basin and in British Columbia will enable us to import not only rubber, but a few other raw materials in larger quantities

that we ourselves require, and increase the revenue gained by their manufacture and re-export from the present $20,000,000 to $120,000,000; a greater increase than this we dare not assume, owing to the strenuous competition from other nations for the trade in both raw and manufactured goods. When we have achieved all this we shall have stimulated to their maximum, apparently, all the major non-food items in our export trade. If we then assume for the innumerable minor items a continuance of the rough balance between exports and imports that prevails today, we shall have a revenue of some $600,000,000 to apply against our imports of clothing, iron and fuel. Direct calculation by higher mathematics, or an indirect calculation by the method of trial and error, will show that with this additional revenue we could maintain the same living standards as today and increase our population to about 35,000,000.

For a country as large as Canada, whose land area is 3,500,000 square miles, a population of only 35,000,000, only 10 inhabitants to the square mile, may seem absurdly small, notwithstanding that nearly one half of its area lies north of the 60th parallel. We cannot wonder that the citizen of England, used to a density of 650 to the square mile, or of mountainous Japan, where the density is about 420, looks across the ocean at our immense and sparsely populated territory with envious eyes, and fancies that it could provide comfortable homes for twice the number of people who now crowd together in his own little island. But the population a country can support depends not so much on its size as on its resources, and in its resources, as we have seen, Canada displays some notable deficiencies.

Is there, then, no hope that we can ever remedy these deficiencies, at least in part, either by reducing our imports

or by increasing our production beyond the limits we set for them in the foregoing pages? Such knowledge as we possess today renders the prospect improbable but not impossible. The estimate that we adopted for the amount of our arable land was very conservative; and a production of only 20 bushels of wheat per acre may seem too low an average considering the heavier yields now obtained in favourable years and their certain increase whenever the use of fertilizers become more general. Then, again, if we raised more sheep and fewer cattle on our grazing lands, and were content to eat more mutton and less beef, we could increase our production of wool and perhaps cut down our imports of that important staple. We must remember, however, that it will require strong economic pressure to bring about intensive agriculture on every available acre of land in the country, and that long before we could bring under the plough all the arable land now covered with forest, and develop to their fullest extent remote districts like the Hay River and the northern interior of British Columbia between the Skeena and Stikine Rivers, the pressure in the more populous parts of the Dominion would probably lower the present standard of living, and no longer allow, for example, more than one person in 10 to own a passenger automobile. And even when our agricultural possibilities were utilized to their utmost they would not permit the addition of more than 4,000,000 or 5,000,000 to the population we have already estimated. Of far greater effect than any effort to extend agriculture into the borderlands would be a uniformly high level in the price of wheat as compared with other commodities; but as long as Russia, Argentine and Australia can produce huge surpluses, and foreign countries can cut down their consumption, if necessary, by substituting other foods, the

price of wheat will remain at a relatively low level, subject, of course, to fluctuations on much the same scale as today.

Heavier than our imports of clothing material are our imports of iron and fuel, and it is in this direction, perhaps, that there is most hope of improvement. No one fully appreciates the immense change that has come over the world from the discoveries and inventions of the last century, and similarly no one can predict what new discoveries may appear before the close of the present century. So although our scientists may appear to despair of finding resources and processes that will abolish the necessity of importing foreign iron and coal, research into these problems continues unabated, and it may be that what seems impossible today our successors will accomplish fifty years hence. Oil we can certainly produce in unlimited quantities as soon as improvements in the hydrogenation of coal permit of its production and transport from Alberta to eastern Canada in competition with foreign oil; and already there are signs that these improvements may not be far distant.

A final word regarding our industrial potentialities, for obviously if we can import raw products as England does, and build up a huge international trade from their manufacture and re-export, we can increase our population to the limit of our food supply by paying for all imports with manufactured goods. This aspect of the problem is not amenable to statistical treatment, but demands a detailed study of the trends in international politics and trade for which there is here no space. Individuals may hold widely diverse opinions. For reasons outlined already, it has been assumed in this paper that, broadly speaking, our industries will operate for the home market, and contribute to foreign countries mainly products that are derived from our own resources.

Summing up, therefore, the maximum population that Canada can support, under conditions not greatly dissimilar to those of today, is very small. Conditions, however, may and probably will change in the coming centuries. The nations of the world, politically and economically, may realign themselves. Some that now import wheat in large quantities may develop stationary populations, and so improve their agriculture or modify their diet that their need of wheat and dairy products from us will decrease rather than increase. Tariffs, too, will alter, affecting different parts of the world in different ways, and establishing large industries perhaps in countries that today seem little adapted for them. The abolition of all tariff and immigration barriers between ourselves and the United States would by itself have a far-reaching influence on our possible population. These and other changes, however, no one can foresee. We can only build our present policies and outlook on conditions that we know and experience, and on such future developments as seem most probable; and these promise us a population not of 100,000,000, or even of 60,000,000 as East thought possible, but of only about 35,000,000, which is less than the present population of either France or England.

Now if 35,000,000 is the maximum population that Canada can support without lowering the standard of living, she certainly cannot provide for the natural increase of her present 10,000,000 and at the same time throw open her doors to unrestricted immigration from the Old World. It will require a careful study of her rate of growth, her transportation facilities, the number of people who can profitably engage in agriculture and the number who must look to industrial expansion for their means of livelihood, before she can determine whether she can absorb any appreciable body of immigrants, even

from the British Isles, without driving her own children into other lands as she has driven them, apparently, in former years.

CANADA'S RESOURCES IN DEVELOPMENT

C. H. MITCHELL

THE development of a new country is, in a great measure, due to the initiative, the resourcefulness and the independence of its people. Where these human characteristics have been found united with great material resources the history of national developments the world over, especially during the past hundred years, has recorded conspicuous achievements in the allied fields of finance, industry and engineering.

The progress of a country's early development in these directions is also influenced largely by the experiences of the past and by the adaptation and adjustment of those experiences to conditions of the present. To some extent it is a process of imitation and often receives impulses from outside sources. In this respect Canadian enterprise, in its earlier stages, obtained no small inspiration from Britain, the mother country, and from the United States, the neighbour; but in more recent years Canadians have worked out their own problems in their own way to meet their special conditions.

Each country or region pursues a distinctive development, which demands design, construction and operation of the necessary enterprises in conformity with the characteristics of the country. These governing characteristics are both physical and human; they depend upon geography, climate, natural resources, and, above all, upon the tastes, habits, and customs of the people in the requirements of their life and business. Canada has features which are peculiar to the country in all of these respects, differing from those of other countries

or regions situated not only in other parts of the world, but even upon the same continent. Canadian methods of development have, therefore, become and have remained distinctive. They have acquired their own national qualities. The initiative and resourcefulness demanded by Canadian conditions have particularly stimulated originality and independence, from which have resulted the distinctive features that make the character of the various forms of enterprise which are being followed in the development of the country now that the Canadian people themselves have awakened to a realization of the value of their assets in the country's natural resources.

It would be interesting to contemplate the extent and manner in which geography has influenced Canada's history in this respect. If the early difficulties of transportation from the sea to the Great Lakes had been less, how differently would the history of the early Canadas have been written? Had the Northland been more accessible, or its invasion been possible at an earlier period, how much further would Eastern Canada's development have progressed? Had the prairies been nearer, or more easily approached through Canadian territory, how much sooner would the older provinces have made their contributions in population? Were the Rocky Mountains a less formidable barrier, to what extent would the Western march of Canada's development have been facilitated, or what to-day would be Canada's advanced position on the Pacific? But harbours and channels to deepen, roads to build, rivers to bridge, railways to push westward, mountain passes to overcome, are but obstacles which foster enterprise and resource in a hardy industrious people and help make a proud history. If these be the price of development,

then the heritage of the Canadian people is all the greater in the experience gained, the confidence acquired, and the consciousness of ability to succeed.

As national developments go, Canada is essentially a new country. Its first people coming originally from France three hundred years ago and from Britain a hundred and fifty years later, occupied only scattered districts in the regions about the Atlantic coasts and the Great Lakes until a period not much more than seventy-five years ago, when the real expansion began. It is only about fifty years, however, since the commencement of a definite movement of population to the regions westward of the Lakes, a movement out to the prairies and to the Pacific Coast.

To visualize Canada in the early periods is to construct a composite moving picture of early colonies gradually expanding into provinces which, in 1867, were consolidated first into the confederation, and later augmented by the western provinces. We must realize, however, that even now the picture, still moving, has but partially covered the great area that is called the Dominion.

The present widely scattered districts of population and development are confined mainly to the Maritime Provinces on the Atlantic, the St. Lawrence Valley, the vicinity of the Great Lakes and their hinterland, and an area not more than three hundred miles wide extending across the Western prairies and over the Rocky Mountains to the Pacific. If an attempt were made to describe this thinly populated area in a figure, it might be said to be a belt three thousand five hundred miles long, varying in width roughly from three to four hundred miles.

Economically, however, Canada presents a figure of much larger size. Its developable area as now being disclosed, containing the most valuable natural resources and largely capable of sustaining population, may be viewed as nearly three times the size of that in which the present population is contained. In other words, the belt can be expanded to a region from eight hundred to a thousand miles in width.

The New North of Canada is now beginning more fully to be realized, and within the past few years a distinct northward movement of population and development has occurred as the more adventurous and enterprising of the Canadians have reached out to these new regions further afield.

It is understandable that a young country like Canada should have had a very active life during this growing period, especially in the past fifty years. Indeed, the history of its material development, particularly where engineering was required, does not date much further back than seventy-five years. That early period was the age of road building and of rail and water communication where steam application was in its infancy and where most of the manufactured articles of use were imported from Britain or the United States. The country then was necessarily agricultural, with such local industry as sufficed to supply domestic wants, and with export trade only in lumber.

Looking back fifty years to the eighties, all Canadians recognize that decade as marking the first comprehensive national movement of development. It was the period of the construction of the great transcontinental highway, the Canadian Pacific Railway, which rapidly became the link to bind the Western Provinces to the East and to create through Canada a new and shorter Empire

route between England and the Pacific.

It is difficult to appraise the value of this railway enterprise in moulding and developing Canada both economically and politically. It was the means of opening up and making accessible the great wheat growing areas of Western Canada, now providing a solid basis for Canadian business and foreign trade. It was by it that the great influx of new population from Eastern Canada, the United States, and overseas obtained access to the new western agricultural lands and it was by its pioneer service that interprovincial trade, so necessary to the young country, was established.

What has followed in the progress of Canada, from those early days when transportation and the requirements of community life in town and city formed the principal demands, has been the history of all new countries wherein valuable natural resources have formed the stimulus to development. Fifty years is not long in a country's life history and yet this period has seen nearly all the development of Canada's natural resources crowded into it. While the population has not yet increased three times, the increase of the country's production from agriculture and its other industries, is indicated by the increases in its exports to the United States, Great Britain and other countries which have grown in value thirty to forty times in fifty years. This is not the place to describe in detail the trend of this expansion through the past forty or fifty years, from the period when the first trans-continental railway system offered the opportunity of a widespread national development, but there are certain directions in which special progress has been made and in which Canada has attained such distinctive success as to attract considerable attention from other nations.

While these directions in which Canada's development has become outstanding are all of a nature in which enterprise and engineering have taken a pre-eminent part, other factors must not be overlooked. With the development of these material resources there has simultaneously progressed the parallel development of Canada's human resources, providing the energy, thrift and intelligence needed to achieve success. The one has made possible the other and the two have marched together. For it is not only in the simple possession of great natural resources that a country's fortune consists. Fertile lands in far flung prairies, wide expanses of forest, boundless mineral belts, great lakes and rapid rivers alone, do not constitute a country. It calls for a people of the right kind to go out and occupy these possessions, to labour on them energetically, to employ resourcefulness, ingenuity and patience in their development.

The various directions in which special progress has been made in the development of Canadian resources, and wherein marked success has been attained, are well known within the Empire and throughout the world. The facts to which attention has thus been attracted entered into the recently proposed policies of Inter-Empire Trade and will have undoubted significance for future discussions of imperial relations. Outstanding in these particular fields of development are agriculture and grain milling, paper manufacture, mining, transportation and water power with its interconnected industries. In order to emphasize and indicate more clearly, the place taken by these key industries in the pattern of the Canadian fabric in its development, a description of each one will be given separately.

Agriculture is, and for many years to come will be, Canada's premier industry. In respect to wheat and its products, of which Canada's exports will continue to form a large part of the world's supply, the success of the industry has been the outcome of co-operation involving diligent labour on the part of the farmer, incessant research by agricultural scientists, and resourceful ingenuity of engineers. By the successive discovery and the use of new types of wheat (Fife, Marquis, Garnet, and Reward), which resist rust and ripen more quickly, a very high quality has been developed which has put Canadian wheat in a class by itself in the markets of the world. By progressive invention and adaptation to Canadian requirements, engineers have contributed the machinery necessary on the land, the storage facilities, the milling equipment, and the transportation by both rail and water, each of which in itself forms a wide field of endeavour.

A significant feature of this industry to-day is the rapid change now being caused by the introduction of mechanised farm equipment of all kinds. Motor cars, tractors, power ploughs, motorised harvesters and "combine" harvesters (whereby all processes, including threshing, are completed in the field in one operation) have rapidly been replacing man and animal labour. In the field the "combine", with its gasoline motors and two operators, is taking the place of six of the "binders" of the last decade with their six men and twenty-four horses, involving a large reduction of labour in this part alone, without considering the many operations of teaming and threshing which have been eliminated by the new methods. A marked evidence of this mechanisation is the absence during the past four years of the harvesters' excursions to the the West which, in the three previous

decades, were an almost national summer event for tens of thousands of eastern men, many of whom remained in the West. This has been a turning point in the agricultural industry; the economic and social significance of the change is apparent. Mechanisation may not yet be wholly a blessing, but whether by it or by a return to man and horse, the Western farmer, facing a permanently lowered wheat price, must devise a permanently decreased cost of production, and do it effectively.

Through the storage and milling of wheat for both domestic and export purposes, Canadians have made a place for themselves. In the storage alone, Canadian grain elevators are unique, and observers from all parts of the world come to study these methods, whether in the small prairie storage or the huge seven-million bushel terminal elevators. The total storage capacity in Canada has now reached about 360 million bushels, of which 150 million is in storage elevators at lake and ocean ports. The consumption by the Canadian people of wheat flour is high, being at the rate of about one barrel per capita per year at a value of between five and six dollars. Against this may be put the quantity of flour exported, which in the year 1929 was at the rate of 1.2, and in 1931 at about 0.8, barrels per capita. The total daily capacity of flour mills in 1932 was nearly 132,000 barrels. Canada has to-day the largest flour mill in the British Empire, with a daily capacity of 24,500 barrels.

The development of forest resources through the paper industry was an outstanding feature of the past decade, and has already been called "the miracle of paper". The rapid expansion of the industry, its magnitude, and its distribution among five of the provinces has indeed been remarkable. It has now become Canada's second greatest

industry, not only in extent, but in value of exports which, although mostly to the United States, get to such distant markets as Great Britain, the Orient, Australia, and New Zealand. In its demand on the engineering profession it has been quite diverse, as there has been a widespread call on civil, mechanical, chemical, and electrical engineers. Economically it is of interest that the more recent additions to this industry were on the Atlantic and Pacific coasts, where tidewater mills have the advantage of direct water transportation. This industry has, however, languished in the past two years in common with so many others; one of the difficulties was the marked overconstruction of paper mills.

The spruce forests for paper are but a recent development; it was to the pine and fir regions providing lumber and timber that early attention was given in Canada's forest industries. The simple lumbering operations of former days have given way to the modern and more complex mechanised methods on a large scale where engineering is a foremost factor. Forest operations of all kinds have now become definite large commercial enterprises, whether for the spruce for paper from the flat sandy island of Anticosti or for the construction timber from the towering Douglas fir in the mountains of British Columbia.

The mining industry in Canada is really not much more than thirty-five years old. In Ontario, gold mining dates back only twenty years, silver thirty, nickel thirty-five, and copper forty years. British Columbia gold and copper mining goes further back, but the industry in Saskatchewan, Manitoba, and Quebec commenced only a few years ago. The smelting of nickel, copper, lead and zinc has developed concurrently, and now large operations

are carried on in Northern Ontario and Quebec, and in British Columbia, where to-day one of its smelters, in "complex" ore, is preeminent in world production. Nickel has been produced in Northern Ontario smelters with such remarkable success that Canada now stands first in the world as a source of this commodity. In gold it stands second, and the large output of the gold mines has during the past two years had a noticeable steadying effect on Canadian business and credit. In lead and copper also, Canada ranks among the most important sources of the world supply.

With iron, however, progress has not been so marked. The iron deposits in Canada, while extensive and widely distributed, are, as so far discovered, not of that high grade which would at present prove attractive for development, especially in the presence of nearby competition from the United States with its higher grades and larger markets. Research in suitable metallurgical processes is, however, progressing in many directions and the successful utilization of the great quantities of Canada's low grade iron ores will doubtless be a distinct feature of the next decade. The exploration for mineral deposits in the far north has in recent years been proceeding to such an extent and in such widespread areas as to form almost a romantic side to Canadian development. The increasing prospecting radius of the aeroplane has disclosed unlooked for possibilities in economic and precious minerals. Who can tell what another decade will reveal?

Coal, mined for thirty years at both coasts and in the vicinity of the Rocky Mountains, has been no small factor in Canadian development. Central Canada is still dependent upon the United States for a large portion of its supply, but the deficiency is slowly being remedied by

means of greater utilization of Canadian transportation facilities. Some surprise was caused by the recent discovery of considerable coal deposits in Northern Ontario, low grade though they are. It is significant, too, that the Alberta coal industry has greatly developed during the past decade in supplying the western prairies. That province alone claims 85 per cent. of Canada's coal resources and 14 per cent. of those of the world, including all qualities.

Canada's future in respect to fuel lies largely in the economic utilization of these low grade coals. For the near future there will require to be a balance maintained between the employment of these natural resources and the relative economies to be secured by importing coal from the United States and Britain. The requirements for the more distant future will, however, be met by the solution of those research problems, both scientific and economic, which are related to the inherent values in the various grades of coal themselves. These values are now rapidly changing in their character and relation to industry, through modern scientific advances whereby the chemical constituents to be extracted will prove to be much more valuable than the coal itself, as fuel in its present physical form. Low grade coals, the world over, are now becoming more valuable and Canada will, in due course, find its huge deposits to be a great industrial asset.

Canada also has its share of the oil resources of the continent and it promises to be large. While oil was a considerable product in Ontario a generation ago, to-day's activity is now centred in Alberta where, under the shadow of the Rocky Mountains, oil of a high quality is being produced in ever increasing quantities. Further north there appear to be many indications of oil and oil

products. It is too early yet to foresee the future of the enormous deposits of oil and tar sands in the Mackenzie River Valley, but it is certain that the next two decades will provide equally dramatic developments which will exercise a marked influence on the economics of the country with respect to uses of oil. A singular application of these tar sands has already been made with success in the construction of several experimental sections of motor highway in the West, using the bituminous sands almost in the raw state.

Transportation is naturally a vital Canadian problem because of the geographical characteristics of the country. Canada's position, situated in the northern part of the continent and stretching across it, demands arterial transportation routes east and west, along the major axis and toward the sea coasts, with such north and south routes as are necessary to provide adequate commercial connections with the United States.

Geographically, Canada has the advantage of lying closest for sea routes to Great Britain and Europe on the one side, and to Japan and China on the other, all great consuming or industrial countries. In matters affecting the relation of Canada to the British Empire, the transportation routes are recognised as commercially strategic in their world position and continental location. For instance, in the export of wheat, mostly to Europe, this advantage becomes apparent when the very large production of the Prairie Provinces is considered. At the present time, when there is some confusion in the wheat markets of the world, not only does the low cost of transportation become important, but the favourable location of the best qualities of wheat is also a factor. In this regard, it is important that Canadian wheat on account

of its high qualities can compete successfully in world markets. In the past twenty-one years, in the annual contests for the International Wheat Championship, the first prize has gone to Canada on seventeen occasions, namely, once to Manitoba, ten times to Saskatchewan, and six times to Alberta.

The sea route from Montreal to Liverpool, normally seven days, is accomplished with not more than four and a half days in the open Atlantic and it is to be observed that the shortest route from New York to Liverpool, following a great circle, passes within 60 miles of Nova Scotia. In air transportation, one noted aviator has recently declared that "North America's aerial comunications between Europe and Asia will centre about northern routes through Canada". Within the country itself, however, there appeared in the early days two physical difficulties in transportation—the wide expanse to the north of the Great Lakes which, in those days, was thought to be barren rocky waste (now rich in mining development), and the Rocky Mountains, five hundred miles across. Statesmen, business men, and engineers alike, recognizing both the difficulties and the advantages of the country's geographical features, have attached great importance to the construction of transcontinental railway routes as a means of developing the country and accelerating its business. As a consequence, after the Canadian Pacific system had been in operation for about twenty years, there came a second cycle of railway building which had its greatest intensity in the second decade of the century just previous to the war, and which later evolved the Canadian National system. There was a time during the period of confusion and uncertainties following the war, when the people of Canada thought that perhaps, in their optimism ten years previously, they had over-constructed

their railways or were in advance of their time. During the present depression it is true that these large railway systems, aggregating 50,000 miles in length, are having grave difficulties with greatly reduced passenger business and constantly diminishing car loadings, but those who take the long view realize that these transportation assets may well be carried at a high valuation in the national appraisal.

During the past few years, even in the face of the overconstruction of railways before the war, more than a thousand miles of additional railway lines have been built, mainly to reach out northward; at the same time there has been considerable consolidation of the trans-continental routes, various stretches of parallel line being taken out of operation or eliminated in the process. Of the new lines thus built, the most notable has been the extension of the Hudson Bay Railway to Churchill where a new ocean port has been developed. This terminus, with its two million bushel grain elevator, will now become a factor in the export of grain from the Prairie Provinces and during the present season with this new outlet to the Atlantic, preparations are already in the making for substantial shipments. A degree of uncertainty will exist for some years as to the potentiality of this route, depending upon the nature of operations and length of season for navigation through Hudson straits which can be determined only by actual trial over several seasons.

Road transportation having entirely changed in character, especially in the last decade, the development of Canadian highways has been very marked. A recent estimate of the total length of all "graded" roads in Canada has been placed at about 240,000 miles of which about 160,000 are "unsurfaced" and 80,000 "surfaced". The latter class has largely been the result of the demand

due to the rapid development of the motor vehicle and is stated by a reliable authority to have cost about $420,000,000 for all types from gravel county roads to concrete provincial highways. This cost is by another authority shown to be nearly one-fifth of that of the railway lines of the country and may be so considered when these classes of road are viewed either as subsidiary to or in competition with them for transportation purposes. This wide network of modern highways has had a marked influence in the development of the country economically, politically, and socially.

Water transportation on the Great Lakes has always been a large factor in Canadian life, naturally dating back a hundred years or more. It has had various cycles of activity due largely to the history of canal construction along the St. Lawrence River, across the Niagara peninsula to overcome the Falls, and through the St. Mary's River at Sault Ste. Marie into Lake Superior. During the past decade the traffic through the Welland canal in the Niagara peninsula and on the St. Lawrence canals has greatly increased, having trebled since 1920, reaching eight million tons in 1928. Much of this has been due to the movement of grain from the head of the lakes and the West.

As these existing canals, built and operated by the Canadian government, have outlived their usefulness in capacity under modern conditions and in meeting the progress of commerce in the country, the government has embarked upon a programme of enlargement. It has already constructed during the past fifteen years, and put into operation in 1931, a new Welland canal 25 miles long, the fourth generation in the succession of canals between Lake Ontario and Lake Erie. It is planned for future development of transportation on the inland lakes with a

greatly increased size, having locks 860 feet long and 80 feet wide with provision for 30 feet depth of water on the sills. This notable new work ranks in size second only to the Panama canal.

The new Welland canal, however, will complete only a link in the new programme of enlargement to provide access for large ocean ships from the sea to the Great Lakes and the interior of the continent. The progression of the new construction programme is, however, from the interior towards the sea and, as one of the main Canadian uses for water transportation is for moving grain seawards, this new link has only a limited use until the link from Lake Ontario down the St. Lawrence river to tidewater is similarly enlarged, because the existing St. Lawrence canals provide only 16 feet depth and have locks only 270 feet long and 45 feet wide. The construction of this further transportation link down the St. Lawrence has been under consideration by the governments of Canada and the United States for the past twelve years and has been the subject of much study by the statesmen and engineers of both countries in the fields of water transportation and hydro-electric power. With various reports and estimates running into hundreds of millions of dollars and with frequent conferences recently proceeding, it would appear that a commencement on this huge joint undertaking may not be far distant. Should this project be undertaken, with its 115 miles of canals and river channel improvements, its nine locks and its miles of dams and embankments, and with provision for the ultimate development of nearly five million horse-power from the fall of 225 feet between Lake Ontario level and Montreal, it will prove to be the largest work of the kind yet attempted. It obviously will call for the best that there is in the engineering profession with the ability, experience

and resource of civil, mechanical and electrical engineers in a combined effort with statesmen and financiers.

It is by its water-power, however, that Canada is gaining notable ascendance. To it directly and indirectly can be traced not only marked industrial economic development, but, in a large measure, social advancement as well, for with cheap electric power readily available to every home in the city or on the farm, social activities are promoted, especially in the rural districts. The total power for which equipment is installed in Canada to-day is 6,670,000 h.p., which is at the rate of 0.65 per capita, a rate which places Canada second in the world, Norway being still the first. This total power is the culmination to date of a development not yet thirty years old, for in 1900 there was only a very small water-power development in the country. It was in the first decade of the century, however, upon the introduction of electric power transmission, that expansion first occurred. That decade saw an increase to a million horse-power, much of it being made up by the large developments at Niagara Falls and on the St. Maurice river at Shawinigan in Quebec. The early part of the second decade brought a further increase in development, adding nearly another million horse-power, while in the latter part, owing to the war, only about a half million was added. This decade was the period in which the great public ownership undertaking of the Province of Ontario was inaugurated and well established. It was in the past decade, however, that the most substantial increases occurred when, following 1920, a period of intensive development commenced. At that date there was a total installation of about 2,500,000 h.p., and the ten years between 1920-1930 added 3,200,000 h.p. or about 125 per cent.

The new Welland Ship Canal. Lock 3, looking south toward the three flight locks at Thorold.

There are many notable hydro-electric power undertakings which were constructed and brought into operation during this past ten-year period. In the early part of the decade the most outstanding one was the Queenston plant at Niagara Falls, of the Hydro-Electric Power Commission of Ontario, with its output of 550,000 h.p., the largest single plant in the world. This, with others of its plants, brings the total of the Commission's capacity up to its recent peak output of 1,250,000 h.p. Another large single development of similar nature is situated on the Saguenay river in Quebec, known as the Duke-Price plant, with over 500,000 h.p., placed into full operation in 1928.

New plants of the Shawinigan Water and Power Company in Quebec have brought its total available power up to over 800,000 h.p. with a further 200,000 h.p. plant now in process of construction. Plants built several years ago on the Gatineau river in the Ottawa valley have an aggregate of 430,000 h.p. More recent large developments elsewhere throughout the Dominion indicate how wide the distribution of power is, there being included in these newer developments: 100,000 h.p. in the Maritime Provinces, by governments and private interests; 400,000 h.p. in Quebec on the Lievre and Saguenay rivers; 225,000 h.p. on the Ottawa river by the Hydro-Electric Power Commission of Ontario, and over 300,000 h.p. on the Abitibi river in Northern Ontario, now under construction; in Manitoba and British Columbia new plants and extensions have recently been under way aggregating between 200,000 and 300,000 h.p.

The situation at the present time is given in an accompanying table (see p. 449) which shows the distribution by provinces, of the power at present developed based upon installation, together with the amounts estimated

to be available throughout the country, as given by the Dominion Water Power Service.

Still more notable, however, will be the power development of the St. Lawrence river, if that undertaking is proceeded with as now appears imminent. In fact, one portion of its development, recently under construction by the Beauharnois Power Company, is now almost completed at a site about 30 miles above Montreal and is sufficient to produce nearly half a million horse-power. Plans for the St. Lawrence Waterway project, as already put forward by the Joint (International) Board of Engineers, contemplate the total development of nearly five million horse-power, of which nearly four million would fall to Canada's share. This would be made available solely for Canadian industry and use, as both the government and the people have already expressed themselves as opposed to the exportation of power from the country. Under plans already conceived, this power, obtained by dams at strategic locations in the river's course, would be developed in five or six separate power stations, varying in capacity from 500,000 h.p. to 1,000,000 h.p. each. If this programme is carried out, the engineering profession will be called upon not only to undertake power stations of the greatest capacity, but to construct the largest hydraulic works yet attempted; moreover, these would be under river and climatic conditions which would present unusual and complex features.

In connection with hydro-electric power, the growing networks of transmission lines in the various industrial centres of the country are all important as affecting economic and social life. Indeed, the widespread transmission of electric power from the numerous water-power plants to the industries of the country has had much to do in stimulating many of the old, and encouraging the estab-

lishment of new, industries. Long high-tension transmission lines, the product of many years of invention, operation, and improvement, are now connecting industrial communities 260 miles distant from power sources. This is the case in the lines of the Ontario Hydro-Electric System, radiating from Niagara Falls at 110,000 volts and from the Gatineau River to Toronto, 240 miles, at 220,000 volts. There are also the Shawinigan Company's lines from the Saguenay river to Quebec, 136 miles, at 165,000 volts. It is of interest, too, from an economic and social point of view, that the Ontario Commission has nearly seven thousand miles of rural lines now in operation, supplying the farms of Ontario; nearly two thousand miles of new lines were constructed two years ago. The far-reaching benefits of the Ontario Commission's system may be visualized when it is understood that it serves nearly 700 municipalities and rural districts. It is unnecessary to emphasize the important contributions which have been made to Canadian life in both economic and social spheres, by this widespread production and distribution of hydro-electric power in such large quantities. Whole communities, large industries, shops, farms, and homes have benefited in town and country, from coast to coast.

It is not desirable to discuss individually the manufacturing industries which have made such marked progress in Canada in the past fifty years. Such a description would be but a catalogue of various kinds of manufacture and a history of the gradual development of these to supply the necessities of a growing population, made possible in the first instance by outside capital and more lately by the financial resources of Canadians themselves. Fifty or seventy-five years ago Canadian industry sup-

plied the simple requirements of the country only in a very limited manner. To-day the conditions are entirely changed. Nearly everything in the way of manufactured necessities ordinarily needed in the country is produced in it. More than this, Canadian industry has, in recent years, taken on a new significance in that there is a steadily growing export trade in certain industrial products, largely for consumption in the British empire. In order to indicate the character of the manufacturing now proceeding in Canada, the following list of products is given, placed in descending order according to their value (as in 1929):—wheat, pulp and paper, flour and grist mill products, meat packing, automobiles, lumbering, butter and cheese, railway rolling stock, electrical apparatus, non-ferrous metal smelting, petroleum products, rubber goods including footwear, cotton products, castings and forgings, bread. For the sake of comparison it will be useful to enumerate the manufactured products which are exported, as in 1930-31, also placed in descending order according to value (in addition to wheat):—printing paper, wood pulp, wheat flour, lumber, copper, spirits, nickel, raw gold, automobiles, rubber tires, silver ore and bullion, farm implements, lead, rubber footwear, meats, zinc and aluminum.

The possibility of this progress in the general development of the country has obviously been due in a great measure to Canada's geographic position, its natural resources in raw materials, its water power and its coal; and more particularly to the diversity of these resources in combination, advantageously situated in close proximity to each other. Add to these advantages, those also of good labour and social conditions, stability of governmental institutions and a contented, industrious and

enterprising people as a whole, and there has resulted a prosperity which is the due reward of a new country. No new country, however, can grow in the rapid manner in which Canada has done, especially under modern conditions and with all the concentration of scientific application and invention which has been necessary, without continually demanding and receiving the highest form of scientific direction in its development. In this regard the universities and the various scientific bodies for encouraging study and research have played a most important part. It has been largely to them that the country has looked to provide and develop the human resources by which the material resources can be brought into use, and in thus reviewing the increasing activities in Canada during the past decades, visualising their progress and their sequence, it is quite obvious that what has been achieved has been due to the efforts, the initiative, and the abilities of a scientifically trained and industrious people.

Now, what of the future? Who will say that these activities and developments are much more than started? It does not now require much imagination to look into the immediate future in view of the activities of the present: for the more distant future a measure is, however, still wanting.

If the extent and nature of the country's natural resources were known, then some measure might be contrived. But they are not known. Not much over half of the agricultural lands is as yet occupied. The mineral possibilities of the country can, as yet, only be guessed at, as the contents of the Precambrian shield have been ascertained at only a few places and much of the territory has not even been explored. Transportation by land, water and air is only partially accomplished and the next

decades will see many more routes opened up, especially northwards. There being only twenty per cent. of the available water power developed, who is going to foretell when, where and in what manner the remainder will be utilized?

No one can say that the end is in sight; far from it. If these national activities can be projected for a futurist picture of only the next ten or twenty years, Canadians may gain a fair idea of where the country is heading in its national advancement. It may not be unduly optimistic to foresee, in this picture, many of the following developments in this further expansion:—

1. The extension of agriculture with the opening of fresh areas further north, where newer types of weather-resisting hard wheat can be developed and grown, may bring into production in the Canadian west, quantities approaching three-quarters of a billion bushels yearly, enabling the export of two or three times as much as heretofore if world markets can take it. The production of other grains and of live stock all constituted in mixed farming, will also doubtless greatly increase not only in the west but in the older provinces.

2. Rail transportation still reaching out northward into new zones, may alter the present geography. It is conceivable that the further development of agriculture, mining and forest resources may bring about new rail routes into northern Quebec and Labrador, to James Bay, to the regions west of Hudson Bay and Churchill, and across to the Pacific between latitudes 56 and 58 and into northern British Columbia.

3. The inevitable further development of the ocean ports will assist in carrying their trade far beyond their present limitations on the Atlantic and Pacific, both in winter and summer.

4. The development of the enlarged St. Lawrence and Great Lakes waterway now almost within sight, will bring inland ports into easy ocean connection for cargoes of large dimensions from the heart of the continent, either on direct routes or by single trans-shipments, and give a great impetus to water transportation, both within the country and overseas.

5. Air transportation, now arrived, will expand far beyond present conceptions. No one can foresee what this may mean in Canada's development, particularly northwards.

6. The manufacture of forest products will take a new form. Apart from conserving and placing the forests on a sustained yield basis, a much more economic use will be made. When the languishing paper industry revives and wider uses have developed, *e.g.* building materials, clothing, etc., new processes now in the experimental stage will utilize other and cheaper woods, especially jack-pine and poplar, whereas heretofore use has been made only of the valuable and rapidly diminishing spruce.

7. Mining, now so well started, will accelerate its development across Canada, especially throughout the Pre-Cambrian areas, not only in doubled or trebled outputs of precious and economic minerals now worked, but of others known to exist. The areas most likely thus to expand first are in Ontario, Manitoba and British Columbia.

8. The fuel problem will move a long way toward solution. Rail and water transportation of coal to Central Canada from the east and west will increase with cheapened facilities. The use of low grade coals, especially those in Ontario and Alberta, will become general by means of new processes of application in powdered form or by liquefaction into their chemical constituents.

The oils of the far northwest will shortly be developed and brought into wider use.

9. Metallurgical and similar processes will be greatly increased in extent and application. Normal methods will develop with other progress. To treat Canadian ores or materials which have special peculiarities, however, new processes will inevitably be developed by necessity, as, for example, to work the low grade iron, and complex ores. Fuels in proximity to such mining and metallurgical works will be a large factor, especially in northern Alberta and northern Ontario.

10. Water-power development will also continue to increase for some years to come. Installations even in present programmes ensure this. More remote prospects and programmes themselves are not unduly optimistic when the necessary power is considered in conjunction with development in other fields. The most significant fact regarding water-power development in Canada is that to-day the installations are only 20 per cent. of the aggregate developable power of all water sources. A marked economic advantage is that most of the water-powers are contiguous to the other large resources of the mine and the forest. When the great power resources of the St. Lawrence are fully brought in, to the extent in Canada of nearly four million horse-power, and with deep water transportation alongside, these combinations will place Canada in a singularly advantageous position for further production and manufactures of all kinds.

These are some of the tasks which Canadians have before them. If they are tasks which may not be approached lightly, it will the more readily be remembered that such tasks have their rewards. It is clear, from past experience and achievement, that Canadians can carry their country a very great way along the road to national

prosperity by diligent, careful and skilful management. Further progress and development in the decades to come will be the logical result.

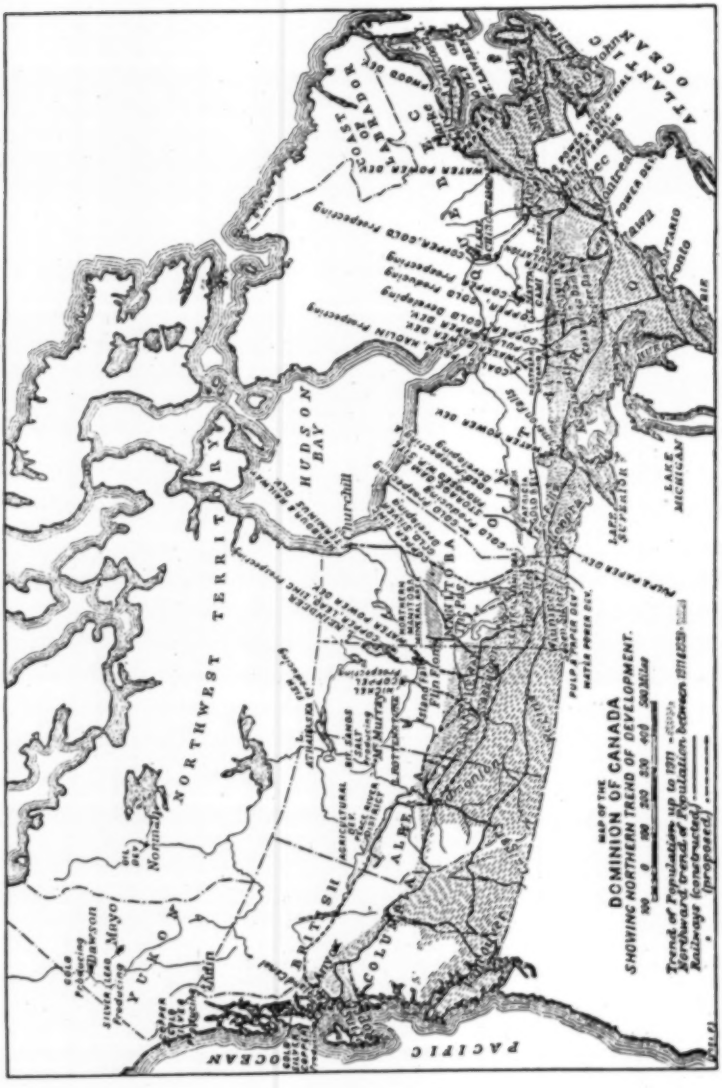
AVAILABLE AND DEVELOPED WATER POWER IN CANADA

AS ESTIMATED AND REPORTED BY THE DOMINION WATER POWER SERVICE, OTTAWA

January 1, 1932

Province	Available 24-hour power 80 per cent. efficiency		Turbine installation h.p.	Population June 1, 1931	Total installation per 1,000 population
	At ordinary minimum flow h.p.	At ordinary six months' flow h.p.			
1	2	3	4	5	6
British Columbia	1,931,000	5,103,500	655,992	689,210	950
Alberta	390,000	1,049,500	70,532	727,497	97
Saskatchewan	542,000	1,082,000	42,035	921,281	45
Manitoba	3,309,000	5,344,500	390,925	699,841	559
Ontario	5,330,000	6,940,000	2,145,205	3,426,488	664
Quebec	8,459,000	13,064,000	3,100,330	2,869,793	1080
New Brunswick	68,600	169,100	133,681	408,255	327
Nova Scotia	20,800	128,300	111,999	512,027	218
Prince Edward I.	3,000	5,300	2,439	88,040	28
Yukon and N.W. Territories	294,000	731,000	13,199	11,346	1064
	20,347,400	33,617,200	6,666,337	10,353,778	664

The estimates of available power are based upon sites where the head is definitely known or well authenticated; they may therefore be looked upon as representing the minimum power possibilities of the Dominion. The two estimates of available 24-hour power are: the first, power available throughout the year, based on the minimum flow, or flow during the dry periods; the second, a mean flow available during the six high months in each year.



Courtesy of "Engineering," London.

Hydro Electric Power Plant on Gatineau River, Que., recently constructed. 204,000 H.P.
Transmission 220,000 volts. 240 miles to Toronto.

NIGHTFALL ON THE EDGE OF THE JUNGLE*

OSKAR KLOTZ

EVERY tropical country has its jungle, and to the uninitiated the word jungle carries with it a hazy picture of crowded trees, dense underbrush, tangled vines and a dank bottom. But the jungle of India bears no resemblance to the jungle of Brazil, Guiana, Venezuela, or Africa, nor can any two be compared, but only contrasted. We might as well compare the meadows of England with the prairies of our western plains, or the prairies with the pampas of the Argentine or the steppes of Russia. There is a general undercurrent of character common to all, but this is swept away by a closer acquaintance.

I know some of the jungle-land of Brazil, with its magnificent trees in almost endless variety, its delicate lianas hanging from mighty boughs or suspended in delicate drapery from trunk and stem and limb, its exotic parasitic plants nestled in the crotch of some broken stump or giant tree, its flowers in rainbow hue visited by equally brilliant butterflies, and all in all exhibiting a riotous passion of nature in colour, perfume and song. An afternoon's tramp through her wildly flaming life brought one home fatigued from the very excitement and thrill that aroused every sense. Birds and beasts of the Brazilian jungle shared in the brilliance of nature's paintings. A medley of colours in their richest hues sparkled from aerial height or from terrestrial level; birds and flowers, lizards, worms and snakes vied with each

*A chapter from the Journal of Dr. Oskar Klotz, written in Africa while he was a member of the Yellow Fever Commission of the Rockefeller Foundation.

other in the beauty of their decorations. Never have I seen such profusion of colour and design; all else in all other lands would have looked drab. But as one becomes satiated with the brilliance of the stage in a modern revue, where the changing lights and highly decorative settings command all one's attention, so too one is wearied by the voluptuous wealth of the Brazilian jungle, where enthusiasm is dampened by the sheer lack of contrast.

How different we find the unchanging and even-hued jungle of West Africa, and particularly of Southern Nigeria. It is as welcome as the presence of the modest and softly-spoken maiden who always commands respect after the flighty, over-dressed, bright-hued and high-heeled flapper whose whole person flaunts the careless exuberance of youth. Such comparisons may tend to mislead; I may, however, repeat that jungles in different parts of the world must be judged upon their own merits.

My bungalow in Africa was not far from the edge of the jungle, so that at evening when the sunset was painting the west in a glorious unbroken splash of crimson, the uncertain zephyrs were lisping in the fronds of the palms, and the birds were reawakening from their afternoon drowsing, I would settle myself comfortably on the mosquito-screened verandah and await the vesperal orchestration of the myriads of animal forms which had been silent since mid-morning. The locust alone had remained sentinel over the day's activities, and to remind the others that he had not forsaken his task, would from time to time rasp his femora and tibials in a paroxysmal outburst of cheer. During the heat of the day he remained perched upon the upper branches of a wild mango tree or flitted occasionally from this to a nearby citrus. The hotter and brighter the afternoon, the louder and wilder became his fiddling. The impudence of him! He would pretend to

lull one by beginning mildly in soft tones, with a few trials and repeats, and then launch forth into full fortissimo with such screech and blare that all thought of a restful siesta was destroyed and one was ready to lead a mass attack against the pesky noise. But just at the moment when the blood pressure had climbed to the maximum and the vessels at the temple were ready to burst with heated exasperation, the fiddler would again modulate his tune and with a slow diminuendo, drowsy and stupefying, would soothe one into forgiveness, only to leave off and terrify one by the awful silence which his rip-saw screeching and deafening intensity of tone can leave. It is hard to believe that this monster of noise is a relative of the cricket who winters in snug chimney corners and sings a friendly song at all hours of the day.

As night descends upon the tropical land, the locust yields place to the noon-hour sleepers. When the sun has descended to an angle of thirty degrees above the horizon, domestic duties call him from his public guardianship. But there is an interval just before sundown after the locusts are at rest and before the evening performers have tuned up. Then as the long slate-blue shadows of the palms stretch across the clearings bordering on the jungle, one after another of the friends we came to know in the early hours of the morning stretch their legs, step a pace or two, preen their feathers or scratch their fur, droop a wing to make sure that the fins of the plane are well set so that there is no danger of a side-slip or tail-spin, and in every way prepare to join in the music of the evening's entertainment, for none may belong to the vesper orchestra who is not properly groomed.

The large fruit bat is the first to finish his toilet. He is a bit careless about his person. He is not particular about vermin and doesn't bother to wash behind his ears.

We have caught these bats on several occasions and were able to collect quite a variety of skin parasites from their persons. During the day they hang suspended from rafters or limbs in shaded places. At night these greedy little fellows curtail their washing and dressing to hurry from their retreats and catch stray midges and small moths before other winged night hunters will enter into competition for these delicate morsels. The bat darts to and fro, angles in and out, turns short corners and flappingly eases his flight while looking for new victims. After an hour, if food has been plentiful, he comes to rest, re-suspending himself from good observation points on trees and water drains, peering with beady eyes into the night whose tender darkness is soothing to his photophobic vision. For short periods he dozes and blinks like a schoolboy who suddenly realizes that he has been caught napping. Even in these idle moments he does not take time to comb his fur though he is more careful of the delicate membranes of his wings. It is hard to understand why the world has turned against the bat and has handed this antipathy to him down through so many generations. In the oldest of our religious portrayals of the nether world, the great arch-malefactor is shown surrounded by all the hateful things of this world and the next, and amongst these we find the harmless bat. All forms of slander have been cast upon him, while in reality he is a most useful scavenger of the air, accounting for hundreds and possibly thousands of insects during each night. In bungalows the bat is particularly happy, for there he is provided with shelter from light and rain, and at the same time with a swarming ground for flying things of many varieties. All bush houses through Southern Nigeria are inhabited by scores of bats and one soon becomes accustomed to them and forgets their crazy flight

when lamps are lit.

The sun has just dropped over the horizon, and for a few minutes we may enjoy twilight. The time is so brief that darkness is upon us before we note that the sun has entirely disappeared. From some distant palms comes a curious plaintive call, in some respects like the mourning dove, in others like the melancholy croon of the misnamed screech-owl. The call is melodious and soothing, beginning with a slow "lu-lu", and then followed by a sequence of rapid "lu-lu-lu-lu". No doubt it is from the character of this call that the natives ascribe its origin to the bird which they name the "O-lu-lu". I have repeatedly sought to verify the relation of the two, but never have been able to spy upon the feathered night-wing and catch him in song, as the bird is perfectly mute during the day, hiding himself in palms and jungle thickets, and little opportunity presents itself for catching him in full-throated ecstasy after sundown. Each evening, however, for an hour or so after the west has forecast the heat of the coming day, mate calls mate, and the greeting, echoing far and near, announces the close of day, as do the holy men from the tall minarets reminding the faithful of their duties to Allah. Should nightfall be threatening, with lowering storm-clouds, our evening sentinel quickens his call and strains his vocal efforts to a greater pitch, that all may know that night portends a restless vigil. This warning uttered, the "O-lu-lu" has done his duty and leaves you to make your peace with the gods and properly arrange your ju-jus[1], before the crashing tornado sweeps over jungle and cottage. Should aught befall you or yours, the burden would be upon your head: the "O-lu-lu" had not failed in his task. Upon such occasions the

[1]In the pagan religion of West Africa, the ju-ju is the material representation of the spirit world, as were the household gods of antiquity. More often the ju-ju is cherished as a charm or fetish.

native is most discreet and does nothing to rouse the evil spirits, and if for several days he has neglected to appease them, he now corrects the matter and duly serves his Lares and Penates.

This soothing, droning, melodious call is again repeated at dawn, or just before the solar arrows pierce the star-lit blue. Fortunately, dawn is never earlier than seven o'clock at the equator, so that our rival to the modern alarm clock cannot make the mistake of a premature call. During the last few snatched moments of the night's rest, the call is repeated and yet again repeated. It is not a harsh and screeching demand which might vex one into refusing to act, but a tender, melancholy note which could not awaken rebellious feelings: one must give in and rise. This "O-lu-lu" strain is like the song of the whip-poor-will: you hear it in the silence of morning or evening and listen expectantly as if you hoped the bird would tell you more. Surely, you think, this bird with his distinct utterance could proclaim world prophecies if he were only encouraged. But his melody is never changed, and still year after year you listen entranced when you hear it again. How responsive is the ear to familiar sounds, which make their record on the cerebral mechanism even during sleep to receive their final interpretation in conscious moments! I was thrilled on the first morning of my return to Africa to be awakened by the bugle notes of my pristine friend. To such thoughts the evening song has diverted me.

Now a finch calls to vespers his fellow songsters from a nearby limb. The weaver bird cackles some harsh reply from his airy perch in a leafless palm. Far off the bushfowl struts restlessly in a gravelly clearing, clucking to her chicks when she uncovers a morsel, while close at hand on a swinging tendril a long-tailed passer faintly

peeps for his mate, who, not so richly garbed in flowing caudal feathers, finds greater freedom in the search for food. Often I have watched this little fellow, the male bird, with his two eighteen-inch feathers, sadly encumbered whether on the ground, his perch or on the wing. On a windy day it is quite impossible for him to travel at will. He must either fly with the wind or remain on his perch. And even this is not so easy to do, for his balance is badly upset when strong gusts strike his ribbons and compel him to tilt his body forwards and backwards like an acrobat. Why should nature provide these impedimenta? Long years have passed since this bird began to develop the distinctive appendage which differentiated him from his cousins; while during the same period, his mate, who has been attending to her household affairs raising successive broods of young, has kept her ancestral form and refused the fluff and feathers of her male partner. How could she properly sit on her batch of eggs, or hasten for food when the hungry nestful awakens at dawn? It is only that dandy whose leisure and idleness allow him time for preening who may wear such outlandish clothes.

In equatorial Africa, on the edge of the jungle, the birds are no longer diurnal in their habits; their melodious madrigals are reserved for daybreak and sunset, while the search for food beyond the pale of the jungle is seldom undertaken during the heat of the day under a cloudless sky. Much more must therefore be done in the short periods of daylight when it is comparatively cool, early and late. The day is as songless as it is cloudless. How quiet all seems: nothing is moving, neither beast nor bird, until the greying sky of evenfall. A sheltered nook is sought where the time is spent in panting and dozing. The only happy one abroad in the full glare of sun and the harmattan is the butterfly, flipping its wings,

sailing from flower to flower, resting a bit on some bright petal, then dashing off again as if to show its importance to all who come.

The contrast of the quickening nightfall is striking at the close of the languorous stillness of the day. The world seems revived, heaviness of limb and mind are forgotten, and senses are sharpened to greater acuity. Man and all the rest of the animal world have had an awakening: they burst forth in song and music, and each is more sympathetic to the others. This vesperal rejuvenation is particularly evident in the grassy vales and the mist-blown leafy bowers skirting the denser woodland of the jungle fastness.

During the rainy season, and this extends over five or six months, the sodden earth breathes its dankness, and the air hangs heavy-laden with pearly beads of mist which glance and glitter in rainbow hues at every angle in the light of my reading lamp. Each blade of grass sparkles with its pearly globes, and every leaflet is covered by the softest down of moisture, which upon touch merges into water of the most mundane quality. By morning the whole landscape is dripping; no water is wetter than that which glides from brush and leaf to soak our clothing as we make an early break through the jungle path. The sun rises as an indistinct orange glow, scarce casting a shadow, and slow in awakening the feathered flock. Only on repeated attempts do its rays break through the low-hanging mists, sending long shafts of light into the eastern bowl of the heavens. The perfumes hang heavy in the sheltered nooks; the grass, the shrubs, the medicinal woods, the rotting vegetation exude their peculiar flavours, not unpleasant on a freshening morning.

As we look around we find long streamers stretching from palm to fern, blocking our path from bough to

bough, or disengaged, floating like a fairy necklace of beads and undulating softly on the morning breeze. The streamers were arranged in their festoons during the night by our good friend the spider, who, to set his trap for the mosquitoes, had to attach some long guy-wires from the most convenient points of security. Why the particular choices are made is not easy for our untrained understanding to grasp. These skilful engineers will span spaces which, in proportion to the size of the workmen, are much greater than the chasm at the Niagara river or the Victoria falls. How beautifully these long threads of web glisten in the morning sun! How well they withstand the early breezes which meet the rising day!

There are always surprises awaiting us at nightfall on the edge of the jungle. The darkening sky brings with it its own night assembly. The mosquito is one of the first arrivals, and the particular variety one may expect depends upon the location of the bungalow. Even in the darkness one may distinguish the song of the Culex pipiens in its higher pitch from the tune of the more wary anopheline, and in its more even and persistent melody from that of the stegomyia. Of the latter group, the Stegomyia fasciata (the carrier of the yellow fever virus) bears his harp upon his back, and by this family crest he may always be identified. A small magnifying glass and a bright light thrown upon the thorax of this mosquito are the only aids to putting this menace to mankind in his proper place, in the catalogue. What little devils these mosquitoes have been, what pests the world over, from the Arctic circle to the equator! No wonder Sir Rupert Boyce was led to write a book on "Mosquito or Man?" But dislike the mosquito as we may, the study of its life, its habits, the varieties, their individual markings, and the relation to disease in man and beast is most fascinating.

What a thrill Sir Patrick Manson had when, working in far-off Amoy, China, he discovered the vector of the microfilaria bancrofti to be the culex mosquito! So accustomed are we now to this sort of discovery that we can scarcely appreciate the picture of the young British medical officer, with his bubbling enthusiasm, working with his microscope and uncovering one of the secrets of nature, the transfer of disease parasites by means of biting insects. This early discovery by Manson (1877) has opened the way to disclosing a whole series of diseases whose parasites are acquired and re-inoculated by mosquitoes, flies, fleas, and ticks. As each mosquito type has its own customs, lives its own life, has a breeding season independent of the others, we must know all the peculiarities of each variety so that we may be able better to combat their varied forces.

To everyone sitting before his bungalow in the tropics, the problems of the mosquito and malaria present themselves. I was fortunate. The small verandah before the hut was screened, and only occasionally did a mosquito slip in as the door opened, or else find a small break in the netting. I could listen to their music and yet not be annoyed. In fact, I rather gloated over the idea that I was a very tantalizing morsel but out of their reach. I wonder whether the unattainable temptation was irritating to the nervous system of the mosquito? Probably it was, for when given an opportunity they showed a vicious temperament. Crowds of these little beasties would congregate upon the screening of my porch, and if I sat reading in the glow of a yellow light, other company from the insect world would join them. Large moths and little moths, june bugs, praying mantis, flat water-beetles, rhinoceros-beetles, giant cockroaches, spiders and clocks, —an evening's collection was always interesting.

But during certain seasons these communings with the insect world were of quite another order. There is one pest which has no respect for man's inventions. He will pass all barriers, he has no dislike of smudges and evil-smelling lotions on the skin, and he will venture his attack at any hour which pleases him, quite heedless of "cow-tails" and fans. This is the sand-fly. What a pesky little mite he is! He passes with ease through the meshes of the wire screening as well as the mosquito bar. He awaits no opportune time to attack, and furthermore he is indifferent as to the region of the body from which he draws his meal of blood, except that he prefers the exposed parts. Walcott and I were at Ifé during the sand-fly season, and during this time we dared not light lamp or lantern for fear the sand-fly would detect our whereabouts. So, dinner over in the evening, we remained within our mosquito tent and entertained each other in darkness with reminiscences of earlier years and homeland scenes, and then to bed. But even with this precaution, the sand-fly found us in our couches, so that by morning my face and hands were a mass of haemorrhagic petechiae,[2] and I hardly recognized myself in the shaving mirror. No smallpox blotched face looked worse. But fortunately the spots disappeared by afternoon and I was quite respectable by evening—only to suffer a new onslaught at night. And so, beside the beauties of eventide, the silvery moon, the gentle breezes wafting away the heat of the day, and the chorus of reawakened birds, there are also some drawbacks, some of them trivial but none the less suggestive of others portending great evil. The native is not far amiss in his display of nocturnal fear.

Large dark patches appear in the starlit tropical sky,

[2]Petechiae are small blemishes of the skin induced by the bite of insects or resulting from poisoning by venoms or disease.

regions appearing bottomless, as if the great spirit had failed to seed the heavens equally with glittering diamonds. The inky blackness of these starless tracts appalled me. The heavens were unconfined and the beyond stretched into infinity. The twinkling constellations, although new to me in their setting, beckoned friendliness with their winking lights, and gave me courage. On several occasions I took a jaunt to the sandy beach of the ocean-front and lay on my back contemplating the heavens. Here and here alone in the whole of Nigeria one could safely lie upon the ground without fear of scorpion, ant or viper. As one looks into the heavens, the stars approach until the silvery canopy descends like the dome of a mansion. The accommodating eye is able to penetrate farther and farther into the depths of the sky and discover new lights in more distant worlds in endless succession. The vastness is overwhelming, but we are assured in our faith by the constancy of the Southern Cross reflected upon the oily sea.

Shoemakers' children go barefoot, and astronomers' sons know nothing of the stars! My ignorance of the heavenly bodies is great. But I do not wonder at my lack of enthusiasm for astronomy when I recall the late nineties of the last century, when the central station of the Astronomical Branch of the Department of the Interior of the Dominion of Canada was contained in two small huts built on the edge of the overhanging precipice above the Ottawa river on Cliff street, Ottawa, and when, as son of the astronomer for the Federal Government I would sit huddled up in those heatless apartments, with the cold on a midwinter night at about 30°F. below zero, trying to keep record of time and signal of the star crossing the meridian. But here, lying in the warm sand close by the beating surf, with no sound save the break

and swish of each regular curler, gazing aimlessly into the depths of space, one has all the conditions for contemplation. The restless sea with its rhythmic beat lulls one's sense to forget the present and its surroundings. An anaesthetic veil obliterates all immediate worldly affairs and leaves the mind to seek adventures in the glowing past, until the voices of companions bring tumbling down all these enchanted castles of our dreams.

Along the Atlantic strand there is very little life to break the monotony of the pounding surf; occasional bats flit across the line of vision, indefinite swirls appear in the oily rolling sea, fireflies at some distance mark the border of the rank grass with the sandy shore, while trilling frogs call from puddles remaining from the last high tide. If the moon is shining, the sea is flecked with patches of liquid silver, and surprisingly this makes the soporific of night still more intense. My good friend Beeuwkes often said that from choice he would sleep on the open sand of the coast, with the full moon pouring upon his face and with the surf beating its languorous time upon the shore. The fascination of these surroundings cannot be matched.

Different as they may be, the sea and the jungle produce a similar effect upon the mind. In truth, the two are companions who meet and greet each other day by day. In Nigeria the jungle comes down to the water's edge, and each morning, stirred by Neptune's western zephyr, nods her head in happy greeting to the sea. The pound of the surf calls a sonorous A-ka-bo (welcome). Both may be rough in their manners if stirred to excitement, but again, on other occasions, no pleasanter companions can be desired. Neither may be toyed with lightly, but must always be approached with due seriousness and respect. Though good fellowship exists between these terrestrial and aquatic neighbours, a guarded truce

maintains their individual rights. In spite of this, at unprotected points the sea makes slashing inroads on the flank of the jungle outposts, where the sandbars protect the shore from the swirl of ever-changing currents. The sands of this western coast are continually shifting, and the character of the currents which sweep the shore shift from year to year and from month to month. Each year a new portion of the coastline is attacked with new vigor, and long reaches of land are undermined and washed away. In the meantime the jungle is not idle, for in those places left at rest for a number of years, the vegetation gradually creeps up to the water's edge and then the mangrove with one step plants itself in the water. Soon more mangrove trees with their mighty and intricate roots extend step by step into the very domain of the ocean, acquiring more and more property for the mother jungle. Thus in foolish competition, the ocean and the jungle stealthily encroach upon each other's rights, neither in reality gaining more than it loses.

We have come a long way from my bungalow, where we first contemplated the nightfall on the edge of the jungle, for once on a wayward jungle path one cannot know where it will lead one. Here on this strip of sand between the jungle and the sea lives a group of vagabonds who poach on both domains. The most conspicuous of these is the brilliantly-hued shore crab, living an amphibian life between high and low tide lines. Here he projects his tunnels whose cellars are always filled with water but whose hatchway may be a pleasant place to bask in the sun at low tide. These grotesque walkers meander about the sodden tide flats scavenging the debris of the last high water. Rarely do they wander far from home, for it disturbed at feeding, they speed a sidewise race for their "better 'ole". They are beautiful in their scarlet and

purple decorations, a matter of wonderment in contrast with the drab tide-sludge about them. Moving about upon their slender legs, stepping high on the tips of their toes, they remind one of a dainty dancer going through some preliminary steps before entering the ballet. These crabs are round-shelled, without tails, having two business-like claws in front and four pairs of slender legs besides.

Other less conspicuous crabs built their tunnels above the high tide, some even hiding their homes under sticks and foliage in the close-by jungle. The land crabs were more drab, their colour resembling the shade of the earth and dried leaves about them. These crabs appear to be vegeterians, collecting fruits and nuts about their subterranean homes. Associated with them but not participating in their gluttony were those interesting walking fish, *Periophthalmus*, ugly pop-eyed bichos, with poor resemblance to fish or beast. When swimming, and this they do poorly, they remain near the top of the water with their eyes projecting above the surface, like miniature crocodiles. On land they wabble up, using their fins for legs. They remain out of water for hours, appearing perfectly content to lie along a small branch or log, or sunning themselves on the slimy flats. To catch them, I set two native boys to work scurrying through the mud flats after the scuttling fish. They caught only a few, most of the fish escaping while the boys were dragging themselves out of knee-deep mud.

Occasional small lizards, young monitors, baby crocodiles, pseudo-centipedes, butterflies and tse-tse flies make up the common inhabitants of the jungle shore. In regions of dense mangrove swamps the black-faced monkey is an interested onlooker of all the parties on the shore.

And now when the disharmony of eventide has spent its fruitless efforts, when beetles and bats and feathered things have sought their resting places in leafy bowers, and when the medley of song and untuneful chorus have been set at rest, the blackness of tropical night closes over the jungle, covering as with a protecting blanket its tender flock within. All is still. Nought will be disturbed until the new break of day. For us, too, has come the time to retire.

THE IDEAS IN KIPLING'S POETRY

LIONEL STEVENSON

ALTHOUGH the right of Rudyard Kipling to be considered the chief living poet of England would probably be warmly upheld by a large majority of the reading public, including not only *l'homme moyen sensuel* but also a good many people who pride themselves on their literary discernment, yet there seems to be a conspiracy of misrepresentation and suppression against him in the current anthologies and critical pronouncements. To be sure, any author who excels in more than one field is apt to suffer, owing to the classifying tendency of critics, who hate to distribute a single author through several of their pigeon-holes. They find it hard to pay equal attention to Hardy as novelist and poet, or to Galsworthy as novelist and playwright, and Robert Louis Stevenson gets unfair play in all his protean activities because they have given him up in despair. Kipling, therefore, having been labeled the master of the English short story, must reconcile himself to being disqualified as a poet.

Against him, however, appears a more active hostility than just this natural lack of perspective. At the risk of seeming equally myopic by ignoring his prose work and concentrating on his poetry, I shall try to pin down some of the elusive accusations and observe them.

His skill and technique are often impugned by the statement that he is a rough-and-ready balladist, a music-hall poet, using vigorous poster effects, but lacking in any subtlety of feeling or delicacy of artistic sense. Familiarity with the whole range of his work suffices to disprove such a view. At the beginning of his career he studied

his craft by the approved methods. His schoolboy contributions to the "United Services College Chronicle" are almost all imitations and parodies of the leading poets, showing real skill in capturing the traits of such diverse masters as Browning and Swinburne. In his first book, *Departmental Ditties*, further practise pieces are to be found—two imitations of Fitzgerald's *Omar Khayyam* and one of Tennyson's *In Memoriam*, an adaptation of the luscious melodies of Poe's *Raven*, a dramatic monologue in the best Browning *Bishop Blougram* style, an excellent parody of Browning's *Love among the Ruins* and an even better one of Swinburne's *Before the Beginning of Years*, a ballade, a couple of sonnets,—in short, all the characteristic exercises of the 'prentice poet. Clearly, then, his skill in forceful images and swinging metres was not solely an instinct; like practically every successful poet, he laboured long and hard in preparation for apparent spontaneity, and imitated predecessors as a necessary step to eventual individuality.

We need not be surprised, therefore, that Kipling has written the only sestina in English that has poetic merit, though the form has been tried by the deftest practitioners of the strict French patterns; or that in *The Craftsman* he was equally successful in Sapphics, with which so many lovers of the classics have pathetically fumbled; or that several of his imitations of the traditional folk-ballads come nearer to catching the authentic indefinable glamor of them than the enthusiasts of the romantic revival ever did. Then there is the tantalizing fragment, *Gow's Watch*, solemnly labeled as "Act II, Scene 2" of some morbid tragedy that might be from the very hand of John Webster, being in both diction and action an epitome of that magnificant decadence.

In addition to these specific instances of difficult *tours*

de force, there are many poems in which he strikes without apparent effort the keynote of some style that might be expected to be utterly alien to him. The artful artlessness of the Jacobean lyric is repeatedly his, as early as 1890 in *The Explanation* and later in *My Lady's Law* and *The Queen's Men* and *A Song of Travel* and the exquisite *Cities and Thrones and Powers*. The urbanity of Horace is to be seen transferred to modern topics: to chemistry, bacteriology and physics in his adaptation of Book v, Ode 3, to the gramophone and the music-hall in *A Recantation*, and elsewhere. Most pervasive of all, an echo sounding throughout his more serious poems, are the sonorous cadences and impressive phrases of the King James version of the Bible.

Having suggested the foregoing defences of his literary background and technical skill, we can proceed to dispute a closely-related notion that his work contains no thought, no intellectual ideas, but is wholly narrative and pictorial. This view is not usually intended to be unfavorable, but in effect it lessens his chance of being regarded seriously as a poet of permanent significance. The impression, which originated at the time when his early poems attracted attention by their vividly objective methods, is still fostered by the anthologies, which represent him by his more exaggerated pieces of bravura, such as *Boots*, *Chant-Pagan*, and *The Vampire*, or at best by spirited yarns like *The Explorer* and *The Ballad of East and West*. Popular though such picturesque works are, they would not justify a claim to poetic greatness, for in spite of the modern revulsion from Victorian didacticism, there is still a pretty general agreement that great poetry entails some sort of interpretation of life, some process of intelligent cogitation.

When the whole range of Kipling's work is considered,

a definite and fairly consistent set of ideas is revealed, an ethical and aesthetic creed which may not be so profound or original as those of some of his contemporaries, but which is a sincere reading of life, firmly in touch with the problems of the age. Read in the light of these general ideas, the more garish poems, such as the *Barrack Room Ballads*, assume a different significance.

A more definitely unfavourable opinion of his poetry, repeated until it has become a *cliché*, is that the only ideas which he expresses are narrowly intolerant and jingoistic. *The English Flag* is cited as triumphant evidence that he regards his own nation as superior to all others, and three or four bitter occasional poems on British relations with Russia, Germany, and Ireland bespeak a degree of prejudice. It is not usually, however, held a sin in a poet to be a good patriot, or even to express vigorously one-sided views on contemporary events. Such controversial pieces are nearly always bad poetry, being dated and shackled by the topicality of both their subject and their excitement, but Milton, Wordsworth, Shelley, and many others have been guilty of thus giving way to intemperate utterance on passing quarrels, without being eternally stigmatized. With them we readily ignore the offending pages; but for Kipling, though the proportion of bad poems is no greater, there is no leniency.

The fact too often overlooked is that Kipling, instead of being a mouthpiece of jingoistic imperialism, is a vigorous critic of it. His intense devotion to his empire and his high ideal for it make him all the more uncomfortable to the orthodox exponents of British supremacy. The whole caste of Anglo-Indian army and civil service officers still regard him with thinly-veiled hatred for the impudent revelations of their follies with which he began his career, and they are prone to insinuate that he was

subversively sympathetic with the native life. Other undesirable types of the "empire-builder" caste are unsparingly displayed in *The Broken Men* and *Gentlemen Rankers*. His poems of the common soldier were the first step toward that poetic championing of the underdog in our social system, which has since been exploited by Masefield; and the frank record of the Tommy's point of view regarding his shilling a day from the Widow of Windsor is generally blamed for Kipling's exclusion from the inheritance of Tennyson's laureate crown. In the orgy of national pride at the diamond jubilee, *Recessional* sounded a clear warning against militaristic pretension.

As a matter of fact, tolerance is the very foundation stone of his creed, and human brotherhood is his ideal—not, to be sure, the apotheosis of mediocrity implied in communistic doctrines, but a brotherhood which admits individualism. His opposition to socialistic levelling, as uttered in *Macdonough's Song*, *A Servant when he Reigneth*, and one or two other poems, arises from his conviction that such a government would be more intolerant and oppressive than any other. But to any artificial barriers of race or religion, to any attempts at coercion, he is vigorously hostile. Again and again he shows that respect or love can surmount racial differences. Some of his most popular pieces enforce this fact—*Gunga Din*, *Fuzzy Wuzzy*, *Mandalay*. The universally quoted—and universally misinterpreted—text of *The Ballad of East and West* sums up his view: when he says "East is East and West is West, and never the twain shall meet", he is not emphasizing the color line, the incompatibility of character and outlook of the two races—utterly the reverse. Preparing for an emphatic contrast, his first line is intended to state the mere physical fact of geography, and then follows the assertion that such material boundaries mean nothing to

the human spirit:

But there is neither East nor West, Border, nor Breed, nor Birth,
When two strong men stand face to face, though they come from the ends of the earth!

The proponents of a dominant religion are anything but admirable in Kipling's eyes. *Buddha at Kamakura*, though deceptively mild and suave, is all the more effective in its thrust at the average Christian's smug superiority. One of his most striking and least known poems, *Jobson's Amen*, is a recension of the theme of *Mandalay* with hearty belaboring of the self-righteous evangelists of Christianity, the white race, and the English breed:

"Blessed be the English and all that they profess.
Cursed be the Savages that prance in nakedness!"
"Amen," quo' Jobson, "but where I used to lie
Was neither shirt nor pantaloon to catch my brethren by . . ."

"Blessed be the English and everything they own.
Cursed be the Infidels that bow to wood and stone!"
"Amen," quo' Jobson, "but where I used to lie
Was neither pew nor Gospelleer to save my brethren by . . . "

To these views we may attribute his persistent affection for Free Masonry, an ideal brotherhood which disregards rank and race. *The Mother Lodge* gives an enthusiastic picture of a particularly promiscuous membership, including soldier and civilian, Protestant and Catholic, Mussulman, Jew, Brahman, and Sikh:

An' lookin' on it backwards
  It often strikes me thus,
There ain't such things as infidels,
  Excep', per'aps, it's us.

For monthly, after Labour,
  We'd all sit down and smoke
(We dursn't give no banquets,
  Lest a Brother's caste was broke),
An' man on man got talking'
  Religion an' the rest,
An' every man comparin'
  Of the God 'e knew the best. . . .

We'd say 'twas 'ighly curious,
  An' we'd all ride 'ome to bed,
With Mo'ammed, God, an' Shiva
  Changin' pickets in our 'ead.

Kipling's eclectic interest in various religions enables him to use their terminologies interchangeably; several of his poems are based on the doctrines of Kabir, the great teacher of Sikhism, while a larger number echo the Koran, the Talmud, and the Kabbala. Most frequently of all, of course, he uses the Bible, or at least the Old Testament, but with appreciation of its vivid picturesqueness rather than with respect for its doctrines. Sometimes, in fact, his handling of it verges on the comic, as in *The Last Chantey* and the second of the *Legends of Evil.* His most solemn invocations, however, are also in Old Testament terms, such as *Recessional* and *Hymn Before Action*, wherein Jehovah has little trace of the milder spirit which Christianity sought to supply.

Not being slavishly bound to any one orthodox creed,

Kipling is obliged to create an ethical code of his own. In some respects it is reminiscent of Thomas Carlyle's doctrines of work and heroes, with an admixture of Browning's theory that the greatest sin is "the unlit lamp and the ungirt loin", the "task declined" and the "footpath untrod", the shirking of "life's set task, be it what it will." In Kipling's system, the greatest virtue is active fulfilment of one's duty; service is the watchword, but service based on individual choice, not external compulsion. His immensely popular "*If*—" is a succinct epitome of the creed: courage, honesty, patience, forbearance, self-reliance, practical application of one's ideals, and—above all—refusal to be swayed by the will of the mob.

By this standard all the specific instances in his narratives and character-studies are to be evaluated. However unlike they may be in other respects, his heroes are all individualists and hard workers, with generosity in victory and fortitude in defeat, who fulfil their part in the world by courage and devotion to their duty as they see it,—M'Andrew, with his Calvinism of steam, Sir Anthony Gloster, the self-made ship-owner, Mulholland, the two-fisted evangelist, and all the nameless Tommies in *Barrack Room Ballads* and *Service Songs*. By conventional morality they are guilty of many sins—wine and women, blasphemy and pride; but by the Kipling code they are glorified by contrast with the talkers, the shirkers, the negative souls, whom the poet torments with unholy glee, —Pagett, M.P., sweltering through an Indian August, or Tomlinson, the respectable citizen, excluded from both Heaven and Hell because he has never done anything on his own initiative.

Poems in praise of work and duty are scattered through Kipling's whole career. In the early *Departmental Ditties*, one of the few serious poems was *The*

Galley Slave, which was apparently intended to be an allegory of the government service, but which in either interpretation—literal or figurative—was a paean on the theme expressed in its last line:

God be thanked! Whate'er comes after, I have lived and
toiled with Men!

A generation later came *The Sons of Martha*, a tribute to the profession of engineering, wherein endless vigilance and daring go unrecognized by the smug majority whose lives are thereby made safe and comfortable:

It is their care in all the ages to take the buffet and cushion
the shock.
It is their care that the gear engages; it is their care that
the switches lock.
It is their care that the wheels run truly; it is their care
to embark and entrain,
Tally, transport, and deliver duly the Sons of Mary by
land and main. . . .

They do not preach that their God will rouse them a little
before the nuts work loose.
They do not teach that His Pity allows them to leave their
job when they damn-well choose.
As in the thronged and the lighted ways, so in the dark
and the desert they stand,
Wary and watchful in all their days that their brethren's
days may be long in the land.

The most impressive apotheosis of action and service is to be found in the dedication from *Barrack Room Ballads*, a vision of the Valhalla of "such as fought and sailed and

ruled and loved and made our world." Kipling pictures them as continuing active duty in the after-life, helping with the most dangerous tasks of controlling the physical universe, confident in the eventual rightness of things and honoured by God because they are of His own type:

They take their mirth in the joy of the Earth—they dare not grieve for her pain.
They know of toil and the end of toil; they know God's Law is plain;
So they whistle the Devil to make them sport who know that Sin is vain.

And oft-times cometh our wise Lord God, master of every trade,
And tells them tales of His daily toil, of Edens newly made;
And they rise to their feet as He passes by, gentlemen unafraid.

The poet lists the chief virtues which qualify a man for entrance into this heroic company as "simpleness and gentleness and honour and clean mirth"; there was a cordial welcome for one "who had done his work and held his peace and had no fear to die." Many of the candidates, it is admitted, have been tainted in their earthly lives by pride; but this venial fault is readily sloughed in the new perspective of eternity. That Kipling regards a life of practical activity as the truest religion is indicated by the last line, wherein the Strong Men are described as "those that praise our God for that they served His world."

Since individual volition must determine all such careers, Kipling has no use for interference, no matter how well-intentioned. Whether missionaries, legislative com-

mittees, or merely private busybodies, he condemns all who seek to regulate the conduct of their fellow-beings. In *The Comforters* he proclaimed the futility of external consolation:

> Chase not with undesired largesse
> Of sympathy the heart
> Which, knowing her own bitterness,
> Presumes to dwell apart. . . .
>
> Time, not thy ne'er so timely speech,
> Life, not thy views thereon,
> Shall furnish or deny to each
> His consolation. . . .
>
> E'en from good works thyself refrain,
> And tremblingly admit
> There is no anodyne for pain
> Except the shock of it.

Just as each human being must live his own life, so he must bear his own sufferings. Thus it is made plain that the service to one's fellow men, which is celebrated in the poems previously mentioned, has to be unobtrusive, even unrecognized, and never officious or insistent.

Kipling acknowledges the paradox by printing in immediate sequence, in his collected edition, two poems that seem flatly contradictory. One is *The Thousandth Man*, warmly praising the virtue of devoted friendship which survives "with the whole round world agin' you"; the other is *The Winners*, an admittedly "heretical song" which asserts and reiterates that "he travels the fastest who travels alone." It is true that *The Winners* was written in Kipling's cynical youth, and the other poem

much later, but his republishing them together implies that he does not consider them so much opposed as they seem. The key to the paradox is to be found in the last line of *The Thousandth Man*—"he will stand by your side to the gallows foot—and after." But he will not interfere to save you from the gallows, if your own free will leads you to them.

A further corollary which Kipling sometimes recognizes is the stultifying power of tradition. Since the duty on which his code is based is not duty to any established creed or caste, but duty to practical life and human integrity, it follows that no outmoded theory ought to have control. In *Rimmon* he depicts the warrior who has seen his ancestral idol disgraced and defiled and who sardonically goes through the ritual of worship merely from consideration of his father's faith. Similarly, in *Our Fathers Also* he shows how the older generation fails to perceive the changes that occur:

> All Profit, all Device, all Truth,
> Written it was or said
> By the mighty men of their mighty youth
> Which is mighty being dead.
>
> The film that floats before their eyes
> The Temple's Veil they call;
> And the dust that on the Shewbread lies
> Is holy over all.

A more bitter version of the same thought is given in *The Old Men*. To this extent, Kipling is certainly not conservative or reactionary.

On the other hand, he does not cherish the belief in progress that has been so vociferous for the past century

and a half. In the first lines of the first poem of his first book he declared,

> We are very slightly changed
> From the semi-apes who ranged
> India's prehistoric clay,

and the same idea recurs in many of the later poems, chiefly those of a satiric turn. Although one of his favourite topics is "culture history", the development of civilization from prehistoric times to the present, nevertheless he insists that no genuine progress is discernible. Outward conditions may change, but the fundamentals of human character remain the same. *The Benefactors* tells how the various forms of weapon, from spear and stone to firearms, were invented under stress of the struggle for survival. *The King* chronicles the imaginative unrest of men, who can find romance only in the remote and antique whether it be the cave-man lamenting the prosaic flint arrowheads, or the modern commuter looking back yearningly to stage-coaches. *In the Neolithic Age* declares that the rivalries of authors were the same "in the dim red dawn of Man" as they are to-day. *A Truthful Song* has a similar tale to tell with regard to the crafts of bricklaying and ship-fitting:

> We tell these tales, which are strictest true,
> Just by way of convincing you
> How very little, since things was made,
> Anything alters in any one's trade!

Particularly interesting, as a combination of this idea with Kipling's creed of self-dependence, is the poem called *Natural Theology*, wherein varied types of people—the primitive savage, the pagan of classic times, the mediaeval

catholic, the modern materialist and the modern idealist —all unite in condemning their respective gods for afflictions which are really due altogether to their own ignorance or stupidity. In conclusion the poet berates them all:

> This was none of the good Lord's pleasure,
> For the Spirit He breathed in Man is free;
> But what comes after is measure for measure,
> And not a God that afflicteth thee.
> As was the sowing so is the reaping,
> Is now and evermore shall be.
> Thou art delivered to thine own keeping.
> Only Thyself hath afflicted thee!

One suspects here a trace, possibly unconscious, of the Buddhistic doctrine of *karma*, with which Kipling was early familiar in his Indian surroundings.

Nor is it merely the anthropologist's record of the human race on earth that Kipling accepts as the limit of the unchanging laws which govern life. In his apocalyptic visions of heaven and hell, another type of poem to which he is particularly addicted, and of which several examples have already been mentioned, he implies that these same basic values of human nature survive through eternity.

So far as ethics and politics go—or religion and sociology, if you prefer the terms—Kipling has been shown to possess a consistent and clearly defined theory, presented sometimes dramatically, sometimes farcically, sometimes by allegory, but always with one underlying assumption—man's individual responsibility to save his own soul through positive achievement. It remains to be observed how he applies his views to aesthetics. Classi-

fying together his poems dealing with literature and those dealing with the other arts, since all of them carry the same implications, we find that he has a decided theory of the artist's function.

His sense of the importance of his calling is shown in *The Last Rhyme of True Thomas*, wherein the shallow pomp and pride of courtiers and kings is contemptuously contrasted with the power of the poet to comprehend all life and touch the inmost emotions:

"For I send east and I send west,
And I send far as my will may flee,
By dawn and dusk and the drinking rain,
And syne my Sendings return to me.

"They come wi' news of the groanin' earth,
They come wi' news o' the roarin' sea,
Wi' word of Spirit and Ghost and Flesh,
And man, that's mazed among the three.

"I ha' harpit a shadow out o' the sun
To stand before your face and cry;
I ha' armed the earth beneath your heel,
And over your head I ha' dusked the sky.

"I ha' harpit ye up to the Throne o' God,
I ha' harpit your midmost soul in three;
I ha' harpit ye down to the Hinges o' Hell,
And—ye—would—make—a Knight o' me!"

In a lighter mood, Kipling draws the same contrast between the men of action and the men of art, in *The Story of Ung*. The hunters and fighters are disposed to make game of Ung, the stone-age picture maker, because he

depicts animals he has never encountered and adventures he has never shared; yet they are fascinated by his work and pay their hard-earned spoils to purchase it.

Clearly, then, Kipling's general theory of the pre-eminence of service and action does not exclude the artists from high honour; on the contrary, he makes it very plain that he ranks them along with the heroes. I have previously cited his dedication from *Barrack Room Ballads* as the strongest statement of his view that the men who "fought and sailed and ruled and loved and made our world" are given much honour in heaven and allowed to continue their careers of adventure and hard work; in a companion poem, *When Earth's Last Picture is Painted*, he represents the artists as similarly rewarded for good service:

> We shall rest, and, faith, we shall need it—lie down
> for an aeon or two,
> Till the Master of All Good Workmen shall put
> us to work anew.
>
> And those that were good shall be happy: they
> shall sit in a golden chair;
> They shall splash at a ten-league canvas with
> brushes of comets' hair.
> They shall find real saints to draw from—Mag-
> dalene, Peter and Paul;
> They shall work for an age at a sitting and never be
> tired at all!

The particular advantages of this paradise, be it noted, are that no critics can enforce their theories, and that every artist is free to develop his own individual interpretation of his material:

And only the Master shall praise us, and only the Master shall blame;
And no one shall work for money, and no one shall work for fame,
But each for the joy of the working, and each in his separate star,
Shall draw the Thing as he sees It for the God of Things as They are.

The ideas indicated in this last stanza are elaborated in a number of other poems, and his doctrine of independent self-expression shows itself to be as important here as in his ethics. The shackling rules and theories of critics are ridiculed again and again, with a persistence that perhaps reflects Kipling's personal experiences with the commentators who were so prompt to condemn him as crude and inartistic. *The Conundrum of the Workshops* shows all artistic efforts, from the days of Adam, greeted with the pedantic wish to classify and confine, the devil's unanswerable challenge, "It's pretty, but is it art?" Incidentally, the poet cleverly interprets the story of the Tower of Babel as meaning the origin of critical theory, with its uproar of meaningless squabbling. Similarly, *In the Neolithic Age* asserts in terms of primitive and modern poetry alike, that all literary jealousies and discriminations are absurd:

There are nine and sixty ways of constructing tribal lays,
And every single one of them is right!

His tolerance of all artistic methods arises from his belief that all aspects of life are suitable for artistic treatment, if honestly regarded; no prejudices are to stand in

the way of a sincere sympathetic record of every human activity. In the poem just cited, he gives his argument thus:

> Still the world is wondrous large,—seven seas from marge to marge—
> And it holds a vast of various kinds of man;
> And the wildest dreams of Kew are the facts of Khatmandhu,
> And the crimes of Clapham chaste in Martaban.

In his own work his primary purpose is to depict this "vast of various kinds of man" as fairly as possible. As prelude to the collected edition of his verse he wrote *The Fires*, saying that the smoke from the hearths under all the roof-trees of the world is blown to him and arouses a friendly response:

> With every shift of every wind
> The homesick memories come,
> From every quarter of mankind
> Where I have made me a home . . .
>
> How can I answer which is best
> Of all the fires that burn?
> I have been too often host or guest
> At every hearth in turn . . .
>
> How can I doubt man's joy or woe
> Where'er his house-fires shine,
> Since all that man must undergo
> Will visit me at mine?

Similarly, in one of his most earnest poems, *My New-Cut*

Ashlar, a prayer of thanksgiving for the joy of artistic creation, the climax of the artist's satisfaction is that "I saw nought common on Thy earth." And his delightful poem *The Craftsman* gives a specific instance of this glorification of the commonplace by making Shakespeare confess how the greatest moments in his plays were suggested by his every-day observations of actual people—Cleopatra wooing a tinker at an alehouse under Cotswold, "gypsy Juliet" railing at the dawn in a Warwickshire ditch, "Lady Macbeth aged seven" drowning kittens at Bankside.

Thus he supports the contention which he advanced in *The King* that romance is not something remote and antique, but is inherent in everything around us, in the steamship and the railroad as well as in sail and coach, in all the things which "with unconsidered miracle hedge in a backward-gazing world." The bulk of his poems carry these theories into practise by dealing with the common people and the current attributes of life. So, modestly, in his dedicatory poem to *Soldiers Three* the supplying of rare jewels is attributed to "stronger hands" and "more cunning brains" than his, whereas he has "wrought in common clay rude figures of a rough-hewn race." The cult of realism in poetry, which has been so strenuously pushed by English and American writers for the past twenty years or less, recommended itself to Kipling a whole generation before the others began, and he has both practised and preached it ever since.

One further article in his aesthetic creed requires particular attention. As might be expected in the author of such unbridled farces as *My Sunday at Home* and *The Village that Voted the Earth Was Flat*, he has a deep respect for the share which laughter plays in the good life. In the dedication from *Barrack Room Ballads* which has

already been cited as an epitome of his belief, there are two separate references to "mirth" as an attribute of his heroes. He prefaced his first and most ribald book of verse by explaining that, although he had shared all the experiences of the life he depicted, and knew the sorrows as well as the comedy, he had written "for a sheltered people's mirth, in jesting guise." In three later poems he gave deeper significance to his belief in laughter by expressing it in terms of religion. *The Jester* tells of the three degrees of bliss in paradise for those who save the souls of their fellow-men: the highest place for him who risks his own soul, the second for him who gives excellent advice,

> And the lowest place is his
> Who has saved a soul by a jest
> And a brother's soul in sport . . .
> But there do the angels resort!

This thought is expanded into a narrative of some length in the Miltonic magnificence of *The Legend of Mirth*. The great archangels are represented as so aloof and dignified in their task of supervising "the tedious generations of mankind" that they are in danger of committing the sin of pride. Allah sends the bland Seraph of Mirth, who tactfully inveigles the solemn archangels into talk of "mundane happenings":

> This they permitting, he, emboldened thus,
> Prolused of human kind promiscuous,
> And, since the large contention less avails
> Than instances observed, he told them tales—
> Tales of the shop, the bed, the court, the street,
> Intimate, elemental, indiscreet:
> Occasions where Confusion smiting swift

Piles jest on jest as snow-slides pile the drift
Whence, one by one, beneath derisive skies,
The victims' bare, bewildered heads arise—
Tales of the passing of the spirit, graced
With humour blinding as the doom it faced—
Stark tales of ribaldry that broke aside
To tears, by laughter swallowed ere they dried—
Tales to which neither grace nor gain accrue,
But only (Allah be exalted!) true,
And only, as the Seraph showed that night,
Delighting to the limits of delight.

Soon the archangels involuntarily contributed reminiscences of their own, until they collapsed in uncontrollable laughter and "in utter mirth forgot both zeal and pride." After their riotous return to Heaven, "shoutingly adrift 'twixt star and star," they revealed their new-found friendliness and tolerance, and when they told their tale against themselves they "received the peace and pardon of the Lord." Thus Kipling justifies the spiritual value of the ludicrous tales that he can weave so well.

More concisely, the same religion of laughter is proclaimed in *The Necessitarian*. Joyously celebrating "the Sacredly Absurd" and "the Jest beheld with streaming eyes and grovellings on the ground," he says that no creed has ventured to recognize the divinity of the Power that gives us the boon of hearty laughter:

Yet it must be, on wayside jape
  The selfsame Power bestows
The selfsame power as went to shape
  His planet or His rose.

It is to be noted that no suggestion of satire or malice

enters into any of these poems in praise of mirth; the function of jests is to save a brother's soul, to promote sympathy and understanding, to make everyday life more joyous.

If credentials are to be granted to a poet on the consideration of his having a consistent aesthetic theory to which his own work conforms, and a consistent ethical theory which has value for the prople of his era, Kipling irrefutably fulfils the requirement. In both the aesthetics and the ethics, tolerance is the keystone. For art and literature, there is to be complete freedom of self-expression, and a sympathetic realism which might take as its slogan *humani nihil a me alienum puto*, and would include a liberal allowance of humour; for the conduct of life, there are to be self-dependence, devotion to duty, and a kindly appreciation of one's fellows that entails no sort of interference with any one's individuality. As a final summary of his whole outlook, two of his poems, not previously mentioned, may be here adduced, poems in which a characteristic whimsicality does not spoil the serious significance of what is said, but rather makes it the more personal and sincere.

One is *The Two-Sided Man*, an appreciation of the tolerant spirit which he finds within himself, and which he regards as his most precious possession:

> Much I reflect on the Good and the True
> In the Faiths beneath the sun,
> But most upon Allah who gave me two
> Sides to my head, not one.
>
> Wesley's following, Calvin's flock,
> White or yellow or bronze,
> Shaman, Ju-ju or Angekok,
> Minister, Mukamuk, Bonze—

Here is a health, my brothers, to you
However your prayers are said,
And praised be Allah who gave me two
Separate sides to my head!

The other general manifesto is called *A Pilgrim's Way*, reiterating his tenets of individual responsibility and brotherly tolerance, every stanza ending with the refrain, "The people, Lord, Thy people, are good enough for me." The poem is too long to quote in full, and too complete a summary to be represented by fragments, so the reader is hereby advised to consult it as the most adequate formulation of the Kipling creed, as applied to literature and life alike.

Poems from every stage of Kipling's career—early, middle, and late—have now been adduced as evidence that he has worked with a clear perception of certain basic ethical and aesthetic principles. The changes in technique and topics, which have resulted from varying environments and the increasing mellowness of later years, do not obscure the underlying harmony of his belief. The chief sources of it seem to be the doctrines of service and achievement proclaimed by Carlyle and Browning, and the doctrine of individual responsibility proclaimed by the Buddhists as *karma*, with a fusing influence of tolerance derived from the new scientific attitude toward religion, which regards all creeds as equally interesting, since all are expressions of the same inherent human instinct. It is ironical that the critics who condemn the Victorian poets for being too didactic and abstract in their philosophizing are inclined to condemn Kipling for lacking intellect just because he avoids such solemn preaching.

THOMAS HARDY

A Critical Examination of a Typical Novel and His Shorter Poems

Frederick Philip Grove

EVEN at this late date, over sixty years since he published his first novel, one hesitates about applying rigid standards of criticism to Hardy's work. It does not matter whether we shake our heads at the curious mixture of humour and romanticism with a classicistic realism of which much, perhaps most, of his work consists; nor whether we eliminate from his poetry such large agglomerations of mere verse as to leave only a slender volume of selections. It is irrelevant that occasionally we get tired of the ceaseless repetition, in verse and prose, of the same themes and thoughts; that we fret at the lack of finality in the form in which they are expressed; that we are repelled by the naked outcropping of purely intellectual intention in the rich soil of his imaginative recastings of reality. To that thought and those themes we return again and again. Once we have sympathetically followed his musings, we can no longer free ourselves from them and from the conclusions which they force upon us. The reason is that Hardy's thought exacts a complete revaluation of accepted values, a reminting of all our intellectual and emotional currency. Hardy, in his searchings, went below the very foundations of life; and, in doing so, he never shrank from any lane into which they might lead him. He is the greatest of the three great educators which the second half of the nineteenth century has produced throughout the world. Considered as educators (and as such, I believe, they

ultimately wished to be considered) Ibsen and Tolstoi stand dwarfed by his side, no matter how much more perfect this one or that one of their works, considered as a work of art, may be than anything Hardy ever produced.

In order to compare these three great educators, we have to restrict ourselves, in that comparison, to their influence on the thought of the present day. All three have been called pessimists, which is equivalent to saying that their thought or their work has proved inconvenient to those who have not yet freed themselves from an obsolescent tradition. All three have attacked conventional standards of morality and conduct. They have *questioned* things. Now it is the task of every educator to question things; the man who accepts convention unchallenged can at best be a teacher or inducator; for education is the process of calling forth in us thoughts and reactions which, while they lay dormant in us, yet had never been evoked before; the educator is necessarily heterodox; he who is orthodox can never be anything but an inducator. Right here we have the point which matters in the present enquiry. Tolstoi questioned the justice of present social arrangements. Ibsen questioned the efficacy of conventional remedies for social ills. But both accepted life as a thing given beyond even the possibility of revolt. Life being what it is, they asked, how can we make the best of it? Hardy goes a step farther; he questions the value of life itself, and above all the value of consciousness, reason, progress, and all that distinguishes the animal from the plant and man from the animal. For Tolstoi, all things are fundamentally right; they become wrong through human sin. For Ibsen all things are fundamentally right; they become wrong through human stupidity. For Hardy, all things are fundamentally wrong; they can become right only through

man's victory over God. "Theirs," God says of men, in one of his poems, "is the teaching mind." This involves a curious point: in spite of his radicalism Hardy is no pessimist. "If way to the Better there be, it exacts a full look at the Worst." That thought is the key to all that is being done today, in the field of sociology as well as in that of serious artistic recastings of life. It is what distinguishes present-day creative effort from that of all previous ages.

Having thus defined the basis of Hardy's greatness, we may be permitted reverently to apply critical standards to a few picked specimens of his work.

For a brief examination, then, of Hardy's work in the field of the novel, we select *The Return of the Native*, the first production of his middle period during which he expressed, in the form of fiction, the fundamentals of his thought and his reaction to life. What is the narrative content of this novel?

A young man who, in contradistinction to the later Jude, has had all the opportunities for a wider and, intellectually as well as materially, prosperous career comes home from foreign parts and wrecks his own life as well as those of his mother and his wife by his refusal to acknowledge the value of accepted standards. This thread of story is embroidered and amplified by two sub-plots and a frame-work. The two sub-plots are the courtship by the reddleman Venn of Thomasin and the somewhat wild and, in places, extravagant intrigue between Wildeve and Eustacia. The frame-work is that of Egdon Heath with its indigenous population, both human and animal. The presentation of the inanimate heath overshadows everything else in the book, both in magnificence of execution and emotional power of percussion.

Right here we lay our finger on a striking characteristic of all Hardy's later work in fiction. The essential plot is enacted, not among those characters who grow directly out of the background of the setting, but among characters who, either by actual physical absence or by spiritual elevation above the level of that background, have been, at least for a time, removed from the soil from which they sprang.

In this lies a strength and a weakness of Hardy's later fiction. A strength, because this artifice, if such it be, enables him, at once and with a minimum of effort, to raise his heroes to a plane of universally valid and generally human values. A weakness, because it induced him to neglect the very thing which he knew best or which, since no reality necessarily corresponded to it, he had most carefully elaborated in typical detail, namely, the commonplace and everyday life of the common run of mankind in his imaginary Wessex. We sometimes fret at the superior and superficial attitude, resembling that of Shakespeare to Shallow, or of Dickens to Micawber, which the author assumes with regard to such characters as Fairway, the Cantles, Mrs. Nunsuch, and others who never rise to the dignity of their, after all, also tragic destinies and are seen, though marvellously well seen, from the outside only. A weakness, further, because Hardy never quite succeeded, though he tried again and again, in making certain slightly worm-eaten and morally ambiguous characters altogether "plastic" or even credible. Eustacia, in the work under discussion, Lucetta in *The Mayor of Casterbridge*, Mrs. Charmond in *The Woodlanders;* or, to take some of the males, Wildeve in *The Return of the Native*, Sergeant Troy in *Far from the Madding Crowd*, Dr. Fitzpiers in *The Woodlanders*, and Alec D'Urberville in *Tess* remain shadowy throughout.

It is only in *Jude the Obscure* that this weakness disappears entirely; and, characteristically, Arabella is a direct product of her environment which, in this case, Hardy takes care to make well known to us; whereas the others appear on the scene from more or less unexplained antecedents.

This predilection of Hardy's for characters of unstable morals is connected with a leaning towards the unusual, the exceptional, the "romantic" in character as well as incident. Magnificent as the execution of the gambling scene in *The Return of the Native* is, such as fairly to challenge the artist in chiaroscuro, it is vitiated by the fact that it is altogether incredible: chance favours the *deus ex machina* Venn a little too much. It might be averred that this scene is a mere incident in a sub-plot; unfortunately it has a pivotal bearing on the central tragedy. That tragedy, however—a double one, between Clym and his mother and between Clym and his wife—is one of the really great things in all literature.

Amazing, too, is the artistic skill and the power of observation and representation employed in the vivification, if I may use such a word, of the inanimate heath with its vegetative cover and its animal inhabitants. It sets off and yet envelops the human destinies like a matrix that produces them by a process of crystallization, with certain curious crystals being evolved that think and pass judgment on the process which produced them!

We touch here on the fundamental point in Hardy's philosophy. It is true, Hardy warns us repeatedly not to cull a system out of his scattered utterances. He deprecates any attempt to look for a "harmonious philosophy" in his work. In the preface to *The Woodlanders* he quotes Gibbon. "The duty of an historian does not call upon him to interpose his private judgment

in this nice and important controversy"—a passage which he paraphrases again in the opening words of Chapter V of Part V of *Jude the Obscure*. But when a novelist and a poet again and again repeats certain statements or expressions and finally forges out of them the whole cosmic framework of the most titanic poetical endeavour made in recent decades, as Hardy does in *The Dynasts*, we are surely justified in using every means in our power to reconstruct, out of *disjecta membra*, the thought that dominated this man's mind.

What, then, so we must ask, is, from a purely philosophic point of view, the central thesis of *The Return of the Native*? This, that, with increasing knowledge and a deeper and more truly differentiating appreciation of all aspects of human life, most of the old and standard values are inverted and a new scale of values is set up.

Clym Yeobright has returned from the great and brilliant world of Paris which he has learned to despise. All the great promise which he gave as a youth of exceptional gifts has come to nought precisely on account of these exceptional gifts. He has come home because he thinks he can there be "a trifle less useless than anywhere else". Even at home, however, he must make a living; and when, under the affliction of his partial blindness, brought on by too much study, he decides to make it as a furze-cutter, he cannot understand why Eustacia who was attracted to him as to a mere visitor from a brighter sphere should object to his choice of an occupation. For him, there is no longer a higher and lower way of doing an irksome thing; there are only differences in the ways of doing it; and these differences are hardly worth the additional trouble some of them involve.

Behind this stands the conviction that conscious and sentient life is a thing to be put up with rather than to

be enjoyed. "Happiness", Grace feels, in *The Woodlanders*, "is but the occasional episode in a general drama of pain." The effect of such a conception of life on him who holds it, is given, in the work under consideration, in the pregnant phrase, "It might have been said that he (Clym) had a wrinkled mind." Yet observe how far we are still from the sweepingly desolate challenge of the dying scene in *Jude*.

Another line of thought is adumbrated in the present work, namely Hardy's ever sharpening criticism of Christianity. This criticism finds its final expression in *The Dynasts* where we read as follows:

SPIRIT OF THE PITIES

What is the creed that these rich rites disclose?

SPIRIT OF THE YEARS

A local cult called Christianity
Which the wild dramas of the wheeling spheres
Include, with divers other such, in dim
Pathetical and brief parentheses,
Beyond whose span, uninfluenced, unconcerned,
The systems of the suns go sweeping on
With all their many-mortalled planet train
In mathematic roll unceasingly.

In *The Return of the Native* the thought is more specific, less devastating and, perhaps, for that reason nearer to our own key of expression. "Human beings, in their generous endeavour to construct a hypothesis that shall not degrade a First Cause, have always hesitated to conceive a dominant power of lower moral quality than their own; and even while they sit and weep by the waters of Babylon, invent excuses for the oppression which prompts their tears."

With regard to human nature, Hardy is anything but a pessimist; note the word "generous" in the passage just quoted. He being noble himself, any nobility of feeling or impulse finds a ready echo in him. But most things seem futile: the noblest effort batters its wings against the bar of an inexorable indifference in the nature of things.

Clym is essentially noble; so is his mother. Yet the two enact between them one of the most appalling tragedies recorded in literature, a tragedy which is not even relieved by great outbursts of feeling, such as might cleanse the air and reconcile the actors to their destinies. Hardy is anything but dramatic. The drama leads by its very nature, as Aristotle saw, to such a catharsis or cleansing. Note how imperceptibly, in *The Return of the Native*, this tragedy is brought about. Clym's side is given in the following passage. When Mrs. Yeobright pleads with him not to give up his career, "He did not answer. There was in his face that hopelessness of being understood which comes when the objector is constitutionally beyond the reach of a logic that, even under favouring conditions, is almost too coarse a vehicle for the subtlety of the argument."

When, later on, Mrs. Yeobright returns to her objections, there is a passage which illuminates like a flash the very possibility of avoiding the tragedy which yet remains inevitable. "Now Yeobright, having inherited some of these very instincts from the woman before him, could not fail to awaken a reciprocity in her through her feelings, if not by arguments, disguise it as she might for his good." And, still later, when she sees that matters have reached a point where further pleading seems useless, " 'Mother, I am going to leave you,' he said, holding out his hand. 'I thought you were, by your packing,' replied Mrs. Yeobright, *in a voice from which every particle of emotion*

was painfully excluded." If only that emotion had not been excluded! But Mrs. Yeobright can help herself as little as Clym, for character is fate. It is the superlative excellence of this tragedy that it arises entirely and inevitably out of the characters of the two protagonists.

Against such triumphs of psychological insight we have to set the failure of Hardy's characterisation, already mentioned, in the cases of Wildeve and Eustacia. Wildeve suffers from a lack of elaboration; Eustacia, from overelaboration of imaginatively unfused detail. In the case of the latter, we are conscious, throughout the seventh chapter of Book I, of an almost frantic and yet unsuccessful endeavour to force us to see; and then, by a simple little touch in the form of a generalization, more is achieved than in pages upon pages of the rest of the chapter. "The only way to look queenly without realms or hearts to queen it over is to look as if you had lost them; and Eustacia did that to a triumph." In the case of Wildeve even such a touch of genius is missing.

Hardy's failure to make Wildeve and Eustacia fully "plastic" is the central weakness of the book; and it leads to the one weakness in its architectural structure: the same artifice of an undelivered message, in other words, a mere external flaw in the flow of events, always to be shunned by the artist, is used twice, in the gambling scene and in the chapter entitled *The Night of the Sixth of November*. As for the gambling scene, Scott might have conceived it, or even Dumas. In Hardy, one regrets that so much magnificent execution should be wasted on hopeless romanticism employed merely to bring about a purely external situation which might have been attended to in a dozen different ways; but this is a mere smudge on the Venus of Milo. And even there a stroke of genius occurs. "They (Wildeve and Venn) were

surrounded by dusky forms about four feet high, standing a few paces beyond the rays of the lantern. A moment's inspection revealed that the encircling figures were heath-croppers, their heads being all towards the players at whom they gazed intently."

This touch is on a par with many others referring to the heath. One marvels at the accuracy of observation wherever Egdon Heath is mentioned. Thus, in March, Hardy has this to say of the gradual awakening from the winter trance, "the awakening was almost feline in its stealthiness." Or, "there was only the imperturbable countenance of the heath which, having defied the cataclysmal onsets of centuries, reduced to insignificance by its seamed and antique features the wildest turmoil of a single man."

One wonders whether the heath was conceived as the background for the human destinies; or whether the human destinies were conceived as a means to set off the heath. Ever since the book appeared, Egdon Heath has been one of the great landscapes in all art.

As regards Hardy's verse, one hears today the most divergent opinions, for critical judgment has not yet had time to clarify itself. The mass of his miscellaneous poetry is enormous; the span of time which it covers, as attested by dated pieces, reaches from 1859 to Hardy's death in 1928. The amazing thing is that a poet should have produced verse for decade after decade and put it away in the drawers of his desk for a problematical later harvest. His range, in this miscellaneous verse, is equally enormous, both in form and content. In content, it varies from the purely balladesque and novelistic to the purely lyric, though perhaps to the casual reader philosophic thought and mood predominate. In form, the

diversity is almost infinite throughout the thousand odd closely printed pages of the various collections, from stately Sapphics to almost jazz-like movements.

By at least one prominent critic Hardy's poetry has been called "predominantly lyrical". I cannot agree. In Hardy, a piece with ever so direct an appeal to our emotional response is often in reality not lyric but novelistic—a fact which Hardy himself called attention to once or twice, especially in that noble pronouncement of his aims, the *Apology* which he prefixed to *Late Lyrics and Earlier*, though the term he uses is "dramatic" ("personative", in the preface to *Wessex Poems*).

In *Wessex Poems*, *Poems of the Past and Present*, *Time's Laughingstocks*, and *Satires of Circumstance*, the first four collections of verse which Hardy published, this is very apparent indeed, for ballad movement and even metre predominate. Perhaps, as we proceed to *Moments of Vision*, *Late Lyrics and Earlier*, *Human Shows*, and *Winter Words*, the first person singular is used more and more frequently even in novelistic pieces; but analysis shows them to be no more purely lyric for that.

Interspersed, however, among the comparatively few purely lyric and the many novelistic poems are a not inconsiderable number of poems of pure thought, designed to express some phase of Hardy's philosophy; and, at a first reading, these are perhaps apt to attract the reader's attention most cogently; they seem, at first sight, so odd. Among the earliest of them is the dated sonnet *Hap* (1866) which, coming as it does from a young man of twenty-six, sounds truly forbidding. *God's Education* and *God's Funeral* command attention by their very titles; *Before Life and After* is perhaps the most poignant one; but the most important of all is undoubtedly the second poem of the triad *In Tenebris;* for it takes direct issue with those

who insist on looking upon this globe with all it contains as "the best of all possible worlds"; and it reveals the sober, thoughtful meliorism which is Hardy's.

It is perhaps worth noting that, while few of these purely philosophic poems are dated, those that are bear date from before the war; and they occur in greater number in the collections published before that event. Which seems to show that Hardy, with increasing age, more or less abandoned that form of direct expression of thought. It is, further, significant for the trend of his development that, in the later collections, we find more and more poems in which a mere picture is drawn which leaves to the reader the task of exhausting its emotional or thought content for himself. Examples are *Ice on the Highway* and *No Buyers*. But even at this stage purely novelistic expression, as in *An Ancient to Ancients*, is by no means rare.

Hardy's fundamental thought, however, penetrates all his poetry perhaps even more poignantly than his prose: the thought that man, in this universe, is in an unfortunate position inasmuch as he is not only conscious but thinks and judges according to standards which nature does not seem to justify. If we call the innate trend of events God, man is morally superior to God, and he does not hesitate to tell Him so. We may, of course, take this as a mere statement of fact or as the poet's bitterest irony.

In studying the novelistic pieces, one observes a curious fact, namely that Hardy rises to his most poignant power only where the theme is one favouring a cynical view of human nature, as in those fifteen "*Glimpses*" which stand at the end of *Satires of Circumstance*, or in such pieces as *The Newcomer's Wife*, *The Duel*, *Just the Same*, or *The Blinded Bird*.

Another result is arrived at by an analysis of the most common themes. After having marked, in an index, all those pieces which are unmistakably novelistic, the present writer picked blindly and at random twenty-five titles and tabulated their themes. It has been said that Hardy's prevailing theme is death. This was not borne out by the tabulation. In these twenty-five poems the theme of old age was represented by one title (*The Two Rosalinds*); death, by two (*The Woman in the Rye*, *A Wasted Illness*); marital or lovers' entanglements, by six (*A Conversation at Dawn*, *She Charged Me*, *Her Secret*, *Had You Wept*, *The Newcomer's Wife*, *His Heart*); the child of another, by three (*A Trampwoman's Tragedy*, *A Sunday Morning Tragedy*, *The Dolls*); the uncanny, by two (*The Chapel Organist*, *The Conformers*); the cynical irony of life, by four (*The Church Builder*, *Ah*, *Are You Digging on my Grave*, *The Curate's Kindness*, *The Ruined Maid*); legends, by four (*The Supplanter*, *Panthera*, *The Lost Pyx*, *The Oxen*); *revenants* by three (*His Visitor*, *The Haunter*, *I Rose up as My Custom Is*).

While such random tests mean little as far as any investigation into the range of Hardy's themes is concerned, it is nevertheless a revealing fact that only two out of twenty-five representative poems deal directly with death. It is true that death overshadows much of Hardy's thinking. It is also true that many poems deal with conditions prevalent in life but revealed only after death (*Her Secret*, *His Heart*); but their theme is not death itself; and it may be questioned whether it is in one of the two poems classified under that heading (*The Woman in the Rye*). The only truth contained in the statement that Hardy's predominant theme is death seems to lie in the fact that his tenour of mind is intensely serious and that he cuts through all the accessories to the

essentials of life. For, after all, Hardy's humour remains episodic (as, by the way, for one who has something to say, it should remain); and it is perhaps not without its significance that its vein is richer, purer, and less contorted in occasional passages of his novels than in his verse. I will quote an example from *The Return of the Native*. " 'You be bound to dance at Christmas,' says Timothy Fairway, 'because 'tis the time o' year; you must dance at weddings because 'tis the time o' life. At christenings people will even smuggle in a reel or two if 'tis no further on than the first or second chiel. And this is not naming the songs you've got to sing. . .For my part I like a good hearty funeral as well as anything. You've as splendid victuals and drink as well as at other parties, and even better. And it won't wear your legs to stumps in talking over a poor fellow's ways as it do to stand up in hornpipes.' 'Nine folks out of ten would own 'twas going too far to dance then, I suppose,' said Grandfer Cantle inquiringly. 'Tis the only sort of party a staid man can feel safe at after the mug have been round a few times'." It is worth noting that the humour is purely verbal; I do not recall a humorous situation in Hardy. – Try "Satires of Circumstance" II.

We arrive at last at a comparatively small group of poems which are purely lyrical, expressive of nothing but a mood of the poet; and perhaps Hardy is greatest in these. In the present writer's judgment, two of Hardy's pure lyrics compete for the first place, *The Darkling Thrush* and *When I Set out for Lyonesse*, the latter being the most buoyant and inspired thing that Hardy ever wrote. These purely lyrical poems alone would insure him a high rank among the poets of the world; for whatever their mood, they are so exquisitely wrought that we

go back to them again and again; and that is, after all, the supreme test for beauty.

Certain of these lyrics, such as *The Wind Blew Words*, *In the Small Hours*, *The Old Gown*, *A Night in November*, are song-like in character and recall the work of Heine. There is evidence to show that Hardy was a student of Heine; he quotes him and translated at least one poem of his; and so, while on the whole the influence of Goethe prevails, we are justified in assuming a certain influence, also, of the lesser of the two great lyricists of Germany. In the last poem named, the brief and rapid transition from an elaborately sketched background to the poignant incident is particularly Heinesque.

Having said that much about form and theme in Hardy's verse, we cannot, in conclusion, shirk the task of reverting to his thought. Hardy called himself, in at least one passage, a thinker; and the very sentence in which he does so, throws a clear light on the problem which stands in the centre of his disquietudes. "A thinker," he says, "is not expected and, indeed, is scarcely allowed, now more than herebefore, to state all that crosses his mind concerning existence in this universe, in his attempts to explain or excuse the presence of evil and the incongruity of penalising the irresponsible."

Existence in this universe, or the value of that existence, is, then, his fundamental problem. As matters stand today, he denies that value; and he asserts that there are, at least in England, many even young people who deny it. It is true that, as far as I know, Hardy never asserts the existence of "a wish not to live" directly, unless we must interpret the poem *A Wasted Illness* in that sense; but it is characteristic that, in the most direct passage dealing with such a wish, in the second chapter of the last part of *Jude the Obscure*, the speaker is a doctor

with an apparently wide experience among the young.

But is it life as such the value of which Hardy denies? Not altogether. It is rather conscious life. He asserts:

> A time there was.....
> Before the birth of consciousness
> When all went well.

And the poem (*Before Life and After*) closes with the cry,

> Ere nescience shall be reaffirmed
> How long, how long?

All, then, went well before the birth of consciousness. There was no illness(?), no love, no loss; regret, starved hope, and heart-burnings were unknown; there was no grief at death and the cessation of things; no suffering in sympathy with pain. If light grew dim and night prevailed, it did not matter. In these stanzas, a course of events is sketched very similar to the course of events in actual progress today; and it is stated that no harm was done.

> But the disease of feeling germed,
> And primal rightness took the tinct of wrong.

The course of nature, then, is right; and only we are wrong because we feel and think, and through feeling and thinking rebel. A rebirth of nescience would right matters at once.

Another poem which in *Time's Laughingstocks*, follows immediately, namely *New Year's Eve*, reaffirms the same thought but goes beyond it in two points. Firstly, man, in a dialogue with God, questions the very wisdom of any

act of creation; and secondly, God represents consciousness as a mere incidental and unintentioned byproduct of creation; He knows nothing of "ethic tests". *New Year's Eve* is followed by *God's Education* in which man definitely asserts his own moral superiority over God. But moral superiority would hardly accept extinction. *New Year's Eve*, luckily, is dated, and the date, 1906, shows that these thoughts pressed for utterance at a time when Hardy was well over sixty years old. Yet he has one more step to take in this direction; and it is taken in the poem *The Blow* in which a human being questions the moral validity of something that has been done to him—by whom? "That no man schemed it is my hope."

> Time's finger should have stretched to show
> No aimful author's was the blow.
> .....
> But the immanent Doer's that doth not know.
>
> Which in some age unguessed of us
> May.....
> .....see and own:
> "It grieves me I did thus and thus!"

Perhaps when he has been sufficiently suffused by man's thought.

But here is the point where, as far as the poems go, even Hardy's cosmic negation pauses. Perhaps God is amenable to education. And in one sense he is; in the sense expressed in *God's Funeral* where God is a "man-projected figure". As man's moral and sympathetic insight deepens, the image of God which he creates in his own likeness becomes sublimated with this image of himself. But a new difficulty arises: this God, man-made,

stands, a phantom, against the world of "uncompromising rude reality" and, therefore, dies.

What is left? Has Hardy said it? Perhaps not in so many words; but what else could be the meaning of those obscure hints, expressed in terms of doubtful interpretation, as these, "See you upon the horizon that small light, Swelling somewhat?" That meaning I interpret as a hope that ultimately man will make himself and the best of his spirit the real master of this world who carries on the work of creation to the point of moral perfection—as, in a sense of which Hardy disapproved, he is already making the worst of himself the dominant force in this world. Man must himself become God.

In this thought, if it be Hardy's, the critic will recognize once again the unity of spiritual striving throughout the world; for the two antipodes, Hardy and Nietzsche, seem to have travelled around the sphere and to have met.

TIME: FROM THE ASTRONOMER'S STANDPOINT

A. VIBERT DOUGLAS

TIME is one of the most fundamental and common of all conceptions; it is also one of the most illusive. The qualifying words, "from the astronomer's standpoint" have been added in order to warn off all optimistic philosophers who might otherwise be led to expect that what is to follow will contain learned remarks upon abstruse aspects of the subject of time, such as these—What *is* time? Has it an absolute quality, or is it purely relative in the sense in which the theory of relativity regards both it and space? Is time directional? How does the mind of man become conscious of the passing of time? Ought we to regard entropy as "time's arrow" in the physical world, as has been suggested by Sir A. S. Eddington? Are time past and time future equally *real* in the sense in which the passing moment which at a certain critical instant we label the present, is real? These are problems which very few people can discuss to the advantage of others.

From an astronomer's standpoint, however, the question of time is less metaphysical, and it embraces such matters of practical importance as the selection of units of time, of arbitrary cycles of time to form the basis of a calendar, and the precise measurement of time.

The unit of time, which by its very nature has been universally adopted as the basis of time-keeping, is the day. If we take the average time which elapses from sunrise to the next sunrise, averaged throughout an entire year, we get the unit known as the mean solar day. Time

measured thus, by the rate of rotation of the earth upon its axis, is called astronomical time.

Here, then, is our fundamental unit; but just as in the matter of units of length it is convenient to have large units as well as small, so also we require a larger practical unit than the day for purposes of chronology. You would not think of measuring the distance from Montreal to Vancouver or from earth to moon in feet; neither would you ordinarily wish to measure in days the time from the battle of Hastings to the present. We must cast about then for a larger unit of time. Mankind has for the most part passed over the unit provided by the revolution of the moon with its cycle of phases, the synodic month, and has settled upon a very natural, practical unit, the year.

Now when we come to consider the question of the number of mean solar days in a year, we find that there are three equally logical ways of measuring this, but that each gives a different result.

The earth's orbit being an ellipse, there is one point on it at which the earth is nearer to the sun than at any other point. Shall we, then, define the year as that interval of time between one perihelion passage and the next? This turns out to be 365.25964 days and is called the Anomalistic Year. It is not, however, a useful unit, for the entire orbit is slowly swinging around relative to the sun and stars, and this causes the perihelion point to move eastward eleven seconds of arc per year.

If we measure the year as the time required by the earth to make one complete circuit of its orbit relative to a point in exact alignment between the sun and some selected star, we then have what may be regarded as the true mechanical year. This is called the Sidereal Year because the earth and sun are regarded as a moving system

within and with reference to the stellar system. Its value is 365.25636 days.

But it so happens that man, struggling to maintain his existence upon the earth, is interested less in the stars than in the earth itself. It can never be questioned that fundamentally man lives by bread, even though it may be added in parenthesis that he does not live by bread alone. Mankind lives upon the face of the earth by bread made from grain grown in the soil of the earth, and so it happens that the two most important events in the cycle of the years are the vernal and the autumn equinoxes—the time for sowing and the time for reaping, the time for the shearing of sheep and for the treading out of the corn. The two most fundamental needs of man, food and raiment, govern his thoughts and actions, and thus the year of chronology is the year of the seasons—the Tropical Year, as the astronomer calls it, measured from one vernal equinox to the next, 365.24220 days.

It seems to have been the great Greek astronomer, Hipparchus, who first pointed out that the Tropical Year was slightly shorter than the Sidereal Year. About 150 B.C. he was comparing the position of the sun against the background of the star groups, or constellations, of the zodiac, at the time of the vernal equinox, with the position as shown in the records of the Chaldeans made several thousand years earlier at Babylon. He found that the point where the ecliptic (the apparent path of the sun throughout the year) crossed the celestial equator had gradually moved westward from the constellation of Aries (the Ram) towards Pisces (the Fishes). No explanation of the advance of this equinoxial point was found until towards the end of the seventeenth century when that master thinker of all time, Sir Isaac Newton, showed that this rotating earth behaves like a gyroscope—the gravi-

tational pull of sun and moon tends to bring the axis of the earth into a position perpendicular to the plane of the earth's orbit, but due to its rotation, it cannot right itself, but does what every gyroscope must do, it precesses or wobbles. This wobble is very slow, one complete wobble in about 26,000 years, which means that there is a corresponding motion, or precession of the equinoxes, amounting to 50.3 seconds of arc per year—and this is why the Year of the Seasons is always 20 minutes 23.5 seconds shorter than the Sidereal Year.

* * * * *

With no precise instruments for making observations at their disposal, the astronomers of a very remote past nevertheless determined the length of the year as approximately 365¼ days. This was done by means of the gnomon, a pointed rod stuck upright in the ground, the length of whose shadow could be measured with fair accuracy. The date when the longest shadow was cast at midday was the summer solstice, and the shortest shadow indicated the winter solstice, while the dates intermediate between these two gave the spring and autumn equinoxes. Observations of this kind made over periods of many years, showed them that the year was not an exact number of days and herein has lain the chief difficulty throughout the ages in the formulation of a completely satisfactory calendar.

At the time of Julius Caesar, the Roman calendar was in a deplorable state of confusion, so much so that the great Roman dictator considered this to be one of the most urgent practical reforms. He therefore appointed an astronomer, Sosigenes of Alexandria, to study the whole matter and draw up a new calendar with a leap year rule that would keep the vernal equinox always towards the end of March, thus ensuring that the civil

calendar and the astronomical calendar would remain in close agreement. There was at that time a discrepancy of about two months between the two systems. Amongst the last of Caesar's great edicts was the one which brought into effect in 45 B.C. the Julian Calendar. The year was to commence with January 1st instead of with March 1st, as previously in the Roman system. The word calendar comes to us, of course, from the Roman name, Calends, for the first day of every month. As the astronomical year was regarded as 365¼ days, an extra day was to be inserted every fourth year. The fifth month, Quintilis, of the old Roman year, Caesar dedicated to himself, and hence it now bears the name July. In similar manner the Emperor Augustus appropriated the next month which therefore was given the name August. The remaining four months still bear the number-names which were theirs in the ancient Roman calendar, being respectively the seventh, eighth, ninth and tenth months counting from March 1st.

As we have seen, however, the tropical year is not exactly 365.25 days but is 365.2422 days. The difference is 11 minutes 14 seconds per year, or somewhat more than three days in four hundred years. Hence as the centuries rolled by, the Julian calendar with its leap day every fourth year, gradually brought the date of the vernal equinox nearer and nearer to the beginning of March.

In the year of the Council of Nice, 325 A.D., the vernal equinox fell on March 21st, but in the year 1582, in the time of Pope Gregory XIII, it had moved forward to March 11th. Clavius, a Roman astronomer, was called upon by the Pontiff to suggest the best modification to the Julian system, with the result that the Gregorian calendar came into force in October 1582, when by decree ten days were dropped completely—the day following

October 4th being called October 15th. By the same decree, it was specified that only those centuries divisible by 400 would be leap years. Thus the Gregorian leap year rule called for three fewer extra days than the Julian rule over a period of 400 years.

This rule serves the purpose admirably at the present time, keeping the vernal equinox between the dates March 20th to March 22nd; and it will continue to maintain this agreement for approximately a thousand years. After that time, however, the date of the equinox will begin to wander forward in the month once more and hence, sooner or later, a yet more accurate leap year rule will have to be introduced. This subject, together with the suggestion that a fixed calendar be introduced, either a twelve- or thirteen-month calendar, has recently been carefully considered by a representative international committee appointed by the League of Nations. Preliminary reports indicate an overwhelming majority for the reformed twelve-month calendar.

In 1582 all the Catholic countries adopted the Gregorian calendar, but not the Protestant nations nor those countries adhering to the Greek Church. England only faced the problem of calendar reform in 1751. Up to that time the year had been considered as beginning in March, as in Rome before 45 B.C. By act of Parliament 1751, the New Year, 1752, was to begin on January 1st and eleven days were to be dropped from the calendar, September 2nd, 1752, being followed by September 14th. Special acts were framed to cover such matters as taxes, rents, and so forth, but nevertheless there was much public misunderstanding, distrust, and resentment. The feeling spread that in some weird way men were to be robbed of

eleven days of their lives and there were riots in various parts of the country, particularly in Bristol.

The Julian calendar is now 13 days behind the Gregorian. In Russia it was only discarded in 1918, and in Roumania in 1919.

Two other attempts to reform the calendar may be of interest. The Eastern Churches, which have never adopted the Gregorian calendar, did, however, form a leap year rule to restrict the wanderings of the equinox, namely, the omission of seven leap years in 900 years. In 1079 A.D., the Sultan of Khorássán appointed eight astronomers to reform the calendar. One of these was Omar Khayyám and he devised a very excellent rule to stabilize the date of the equinox—seven quadrennial leap years and then one after five years, that is, eight leap years in thirty-three. The disadvantage of this is that one cannot tell by inspection of a date whether or not it is a leap year.

The fixing of Easter in the ecclesiastical calendar depends upon the Metonic cycle of very ancient origin. In 433 B.C., Meton found that 235 synodic months (revolutions of the moon about the earth) corresponded very closely to nineteen years of 365¼ days. Hence it happens that every nineteen years the phases of the moon recur on the same calendar day, with a possible one day difference according to the leap year adjustment. Thus Easter, being set as the first Sunday after the first full moon after the vernal equinox, falls on the same date (or one day before or after) every nineteen years.

Before leaving the subject of calendars, mention should be made of a very useful system of chronology, introduced in 1582 by J. J. Scaliger, a noted Italian scholar. It is simply the sum total of days since an arbitrarily selected starting point—B.C. 4713 January 1.

Reference to a Julian day calendar tells us that 1932 January 29 is J.D. 2,426,736. For the study of periodicity in the brightness of variable stars and kindred phenomena, this calendar is invaluable.

* * * * *

Thus far we have been regarding the day as a perfect unit of time, ready-made for the use of man. But, it may be asked, where would we be if it were found that the day is not constant, that the rate of rotation of the earth is a variable? The answer to this is that we would be exactly where we are—for it is now known beyond all doubt that the day is not constant, indeed it is not even a regularly changing variable! Astronomers have suspected this for a long time, but only recently, owing largely to the investigations of Professor E. W. Brown, has this been fully established.

Astronomers find in the sky four clocks that can be observed with great precision. Clock A, keeping what we have called *astronomical time*, is the rotating earth, relative to the sun; clock M is the moon in its revolutions about the earth; clock S is provided by the planets Mercury and Venus in relation to the sun, the outer planets being unsuitable as time-pieces due to their very slow angular motion about the sun; clock J is the system of Jupiter and his satellites for which long series of accurate observations are already in existence.

What we find is this: A differs from M, S, J; M differs from S, J; and J differs from S. It is the clock S that appears to keep what we may, if we wish, define as true mathematical time. What then is wrong with A, M and J that they behave as good clocks ought not to do?

Clock J is a very complicated system. Nine satellites revolve about Jupiter in periods from about twelve hours to more than two years. The inner four of these,

discovered by Galileo in 1610, January 7, have been the subject of intensive study by the Cassinis, a "dynasty" of Italian astronomers who directed the researches of Paris Observatory from 1669 until the Revolution, 1793; by Bradley, Wargentin, Delambre; by Lagrange at the instigation of the Paris Academy which offered a prize in 1766 for the best essay applying the principles of celestial mechanics to the problem of the Jovian satellites; and in more recent times, by Sir David Gill at the Cape Observatory, and by Dr. W. de Sitter, whose interest in this subject has extended from 1896 to the present day. The result of all this work has been that the masses of Jupiter and his four major satellites are known with an accuracy unequalled in the case of any other members of the solar system; but the time-keeping of this clock throws no clear light on the vagaries of clocks A and M.

Regarding S as the standard clock, it is found that both A and M lag behind it. These lags can be analysed into a uniform retardation, but to different amounts, A more so than B in the ratio 1:0.77; and in addition to this, both A and M are sometimes gaining slightly and sometimes losing, these changes taking place simultaneously but four times greater for A than for M.

What causes can be at work upon earth or moon or both to produce these results? Many causes rise to mind, but two only will survive the ordeal of critical examination. One of these is *tidal friction* between earth and moon, affecting both clocks; the other is erratic, unpredictable changes in the moment of inertia of the earth altering in either direction its rate of rotation. This latter change can only be brought about if there be deep-seated changes in the distribution of mass within the earth, redistributions which take place sometimes quite suddenly, evidently in the deep semi-viscous inner layers or core.

We know that no known surface readjustments could have produced, for example, the abrupt shortening of the day in 1918, from 1/650 of a second longer than the average to 1/540 less than the average. Dr. de Sitter has stated that if the whole Himalayan range and the entire highlands of Central Asia had suddenly sunk to sea level, the resulting change in the moment of inertia of the earth would produce a change in the day only one-quarter that of the 1918 change. A uniform ten-inch contraction of the diameter of the earth would account for that particular change, but the more favoured hypothesis is that of the deep-seated earth movements. Such abrupt alterations in the earth's rotation took place in 1755, 1786, 1864, 1876, 1897, 1918.

These changes within the earth are immediately balanced by the changes in rate of rotation and have no effect upon the time-keeping of the moon.

Tidal friction, however, both retards the earth and accelerates the moon. The moon's gravitational attraction raises a tidal wave in the ocean, which travels around the earth as the earth rotates. There is very little frictional loss of energy in the deep oceans, but in the shallow seas and channels, and in the Arctic and Antarctic oceans, where ice is lifted, distorted and broken up by the tides, it is evident that the expenditure of energy in friction is considerable. It has been estimated that the rate of dissipation of energy by tidal friction is about two thousand million horsepower. At least one-third of this can be definitely ascribed to certain well-known and carefully investigated places—Irish sea, English channel, Behring sea, straits of Malacca, for example.

One effect of this friction is to retard the earth's rotation. This amounts at the present time to about 1/1000 sec. per century, but it is not a constant. The

reaction on the moon must be considered: tidal attraction tends to accelerate the moon, hence it recedes by centrifugal force, and hence by the third law of Kepler its period of revolution is lengthened, or in other words, there is observed a retardation of clock M. Furthermore, this effect is more pronounced at perigee, when the moon and earth are nearest, and thus the retardation varies and, in addition, the eccentricity of the moon's orbit is probably being increased.

* * * * *

The construction of artificial timepieces has been a subject of investigation by many of the most skilful workers and thinkers in times past and at the present day. From the simple hour glass with its trickle of sand and the ancient water clocks of the Chinese to the chronometers and master clocks of to-day there is a very long record of human endeavour, discovery, invention, and delicate craftsmanship.

The "escapement drive" marked a great advance in the construction of accurate clocks, but this has now been superseded in the Shortt clocks working on the "free pendulum" principle. The clock is sealed into a case having careful temperature control and evacuated to a pressure of about 15 mm. mercury. The motive power is supplied electrically by a "slave" clock. Two such clocks are at the Royal Observatory, Greenwich (Shortt Clocks No. 3 and No. 11); two at the Royal Observatory, Edinburgh (No. 0 and No. 4); and three are at the Loomis Institute, Tuxedo Park, N.Y. (Nos. 20, 21, 22).

The constancy of the best of these clocks points to the remarkable conclusion that such a clock may be "depended upon to keep time within a few hundredths of a second for a period measured in years".

For periods of time not exceeding a day, the best clock

is a crystal oscillator. This method of measuring very minute time intervals with extreme precision has been developed at the Bell Telephone laboratories, New York, and the comparison of such an oscillator with the Shortt clocks at the Tuxedo Park has been perfected by Mr. A. L. Loomis, recently. The crystal oscillates 100,000 times a second, and by means of a beautifully designed chronograph, a change in the rate of a clock of one part in a million would be made evident by inspection of the chronograph record after only a few hours run.

Continuous records of the oscillator and three Shortt clocks were made with this chronograph extending over the periods of 55 days and 147 days respectively. These have been analysed by Professor E. W. Brown and Dr. Brouwer in order to trace the causes of the slight variations of the clocks relative to the crystal oscillator. The results are most interesting, pointing to a sensitivity to extraneous influences on the part of the clocks and connections wholly unbelievable by those unfamiliar with scientific precision measurements. They found a semi-diurnal variation amounting sometimes to 3/10,000 sec., which they ascribed to daily temperature changes affecting the signalling system between their laboratory and the master oscillator in New York.

A further periodic change of about 2/10,000 sec. was found to be linked with the daily tidal periods, due to the gravitational pull of the moon upon the bob of the pendulum of each clock, augmenting or offsetting to a small extent the earth's gravity which so largely determines the period of swing of a pendulum.

Another periodicity of much greater magnitude than either of these, amounting to 1/50 sec., was traced to natural oscillation of the piers to which the clocks were

bolted. By changing the clock positions, this was eliminated.

To quote Professor Brown: "This is the first time that a continuous record has been made of the performance of a clock to a degree of accuracy beyond that of the clock. . . . . Four such clocks, under proper conditions of temperature and pressure control, could possibly furnish a control of the annual changes in the rate of rotation of the earth".

* * * * *

Within the last two years a very disconcerting thing has happened. As was stated at the outset, the astronomer embarked upon the sea of time with every intention of so laying his course that he would avoid the dangerous shoals and reefs of metaphysical abstractions. But suddenly and unexpectedly he has found himself in the midst of a whirlpool of seething uncertainty.

In 1924, Sir James Jeans carried out a series of calculations to determine the age of the universe. There were four avenues of approach to this problem: (1) from the known masses of typical stars and their rates of loss of energy by radiation; for example, the number of years which must elapse before a star like Sirius would become like our sun is calculated to be at least a million million years, hence on the current ideas regarding the life-history of stars, the sun must be of an age greater than that figure; (2) from the scattering apart of stars belonging to a moving cluster, such as the Taurus or the Ursa Major cluster, the stars of which undoubtedly have had a common origin and once moved through space in parallel paths with a common velocity but, owing to the haphazard gravitational influences of the other stars, some of the cluster stars deviate from their courses and thus with the passage of time the cluster

gradually opens out and loses its compactness; (3) from the sizes and shapes of the orbits of binary stars which must have been the result, likewise, of random gravitational influences of other stars, tending to separate the members of a multiple system and cause their orbits to become elongated; (4) from the degree of equipartition of energy which we find in the stellar system, massive stars moving slowly and less massive stars with greater velocities—again it is a question of mutual gravitational influences which in an infinitely long time would bring about a perfect distribution or partition of energy, a state not yet attained by the stellar universe.

All these considerations led to the belief that the age of the universe was of the order of 10^{14}, or a hundred million million years. This was regarded as a satisfactory result by both astronomers and geologists, and for six years it was unchallenged in any serious way. Then came the Abbé Lemaître's theory of the instability of the Einstein model of the universe, and the consequent interpretation of the observed recessional velocities of the remote spiral galaxies as indicative of an expansion of space. Sir Arthur Eddington was the first to deduce from this new theoretical approach to the problem of the nature of the universe some numerical estimates of the size of the "original" universe at the time when expansion of space began. Likewise from the Einstein relations the total mass of the universe was estimated, and then on the assumption that the radial velocities of the spirals are a measure of the expansion of space now in progress, it was calculated that this expansion cannot have been in progress for an infinite number of years, nor even for a million million years; for ten thousand million, perhaps, or even a hundred thousand million years, but not more.

This then would seem to set an upper limit to the age

of the universe, for stellar evolution could not have been in progress, before the expansion of space began, if Lemaître be correct in his conclusion that the primordial tendency of nebulosity to begin to condense into individual stars leads automatically to a tendency towards spacial expansion.

How are these two time scales to be reconciled? Each is based on a series of logical deductions from apparently justifiable premises with the observed facts of astronomy as the foundation stones.

It is undoubtedly a discouraging outlook. There are, however, those who would have us believe it was inevitable that we should sooner or later find ourselves in this *impasse* with regard to time, just as the physicist, in regard to light, and later still with regard to matter, reached the *impasse* of having two mutually contradictory theories, each of which was essential from certain specific points of view. He regards light as an electromagnetic wave and thereby very satisfactorily explains certain phenomena—reflection, refraction and interference of light. But other phenomena, photoelectricity and the theory of spectra, demand the Quantum theory, which pictures light as being not a continuous wave but a series of discrete, indivisible quantities of energy like a stream of machine-gun bullets. So, too, matter is ordinarily regarded as made up of particles, electrons and protons, but certain experimental results of the last few years force the physicist sometimes to regard the electron or proton as a train of waves. Even space has not remained unambiguous, there being some phenomena which point to the necessity of thinking of each electron as carrying about its space with it—a space into which another particle cannot penetrate. Is it now necessary to regard time in some such metaphysical

manner?—to regard these two evolutionary processes as coexistent and equally true because neither has really anything to do with the other?

Dr. de Sitter, speaking last year in London, expressed this attitude of mind, "I do not think it will ever be found possible to reconcile the two time scales".

But need we sit down with this air of patient resignation to the inevitable? It seems too early in the day to accept this as the final dictum. We do not want to obscure our recognition of the inadequacy of our physical knowledge by stupifying our senses in the atmosphere of a semi-mystic metaphysics. We ought to keep in mind this obvious fact, that our units of time and space have been derived by observations and measurements made within this galaxy, that is, in "static" space where gravitation counterbalances the forces tending towards expansion, and it is not inconceivable that an ambiguity arises as soon as we use these units to measure time and space outside the galaxy in the region subjected to spacial expansion. The atomic clocks in the distant spiral galaxies are, like our own clocks, beating time in a "static" space, but their energy messages travel to us for millions of years ("static" space unit of time) through this strangely stretching space, then the messages enter "static" space one again, come to our spectrographs—and we interpret them in the same way as though their paths had never lain outside the "static" regions of space. Perhaps along this line of investigation a ray of light may be found.

Until light from some expected or unexpected source does illuminate the scene, this problem of the time scale of the universe remains as a definite challenge—a gauntlet flung at the feet of the astronomer.

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